A Good Egg: An Evaluation of a Social Behavior Change Campaign to Increase Egg Consumption Among Children in Rwanda

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Dedication

In 2012, while living in Kisumu Kenya, my husband and I hired Lydia, a gracefully beautiful but shy woman, to do our laundry twice a week. We had no washing machine, and with two small children, offering Lydia this job provided us much needed help and her a chance to stay in the city with her boyfriend. Lydia's mother had passed away, and life in her rural home was a struggle that she had come to the city to escape.

Through the months, Lydia's belly began to swell, and we all became excited about the pending birth. I had just had my second child, and I was excited for her to enter motherhood with her first. However, on a trip back to the US to show my parents their new grandbaby, I received a phone call relaying unthinkable news. Lydia had died in childbirth, leaving motherless the twins she hadn't known she was carrying.

I sat with this devastating news, looking down at my own cherubic baby, struck by the injustice of the world, made so immediately visceral. Lydia did not need to die. I thought about the American birthing experience, and our hyper-focus on crafting that experience: making birth-plans, interviewing doulas, researching hospitals. We worry about shaping the experience, but never about surviving it. That is not the case for so many women around the world, who die largely due to lack of access to quality care.

Lydia's death left two sickly babies who were taken in by her boyfriend's mother, Esther, without hesitation, but with much worry. Esther, who lived in a village several hours away, did not even know of Lydia's pregnancy. She met Lydia just before her dying day, when Lydia, sensing her impending death, asked Esther to take care of these grandchildren saying "You may not know me, but these children are your blood. Please

care for them. I have named one Michael for my father and the other one you may name." Esther could not refuse. She named Michael's brother Joseph.

Upon returning to Kenya, we went to visit Esther to offer support, and we found her struggling. She hid those struggles under gracious hospitality, but her challenges came out the more we visited. She had to quit her job selling mangoes to care for the babies, who kept her up all night. She was exhausted and perpetually worried about her finances. Michael had already been through one bout of malaria, and they worried he wasn't going to make it. She had no infant formula to offer them and even tried to nurse them, but with the twins it was too hard. Baby formula is not readily available in the rural areas, so she was giving the newborn babies a thin watery porridge and milk, when she could afford it. Still, Esther was loving and strong-willed, and insisted on caring for them so that her son, the baby's father, could finish his college degree.

After our visit, along with some other friends, we began providing her formula for the twins as well as other assistance. Formula, so often eschewed in America in favor of breast milk, may have saved these boys lives. It certainly helped them grow during such a critical time of development. Just a few months later, the boys were fat-cheeked and healthy, and Esther had come out of the hardest days. Ten years on, we still get pictures of the boys – now thriving in school.

I've long been struck by the importance of early nutrition in shaping the rest of a person's life, and the fact that the brain simply does not develop the same without adequate nutrition, particularly early in life. Pause on that last point. You, along with your ability to think, focus and achieve, would not be exactly you, if you started off life with an inadequate diet. Most of us want to live in a world in which people can rise to

heights of their potential, a world in which they can overcome adversity through gumption, perseverance and personal talent. The fact that this individual potential can be stymied from the earliest days is nothing less than a travesty. It compounds pre-existing global inequities, and the overall squandering of human potential is incalculable. Michael and Joseph's story is a potent reminder of that. This dissertation is dedicated to those children, past and present, who deserve the complete building blocks of their full actualization. Amid such global abundance, we can and should do better by you.

Acknowledgements

No dissertation is truly the product of just one person's work, and this one is no exception. While the design, analysis, and writing are all mine (as are any mistakes), the intellectual and material support offered by others are very present in these pages. Thanks to Kathy Newcomer for her continual guidance, timely reviews and introduction to the latest statistical debates. Burt Barnow helped me think through various analytical methods and asked probing questions about the treatment arms which helped me clarify my writing. Emily Smith ensured I was abreast of the latest nutrition literature. Their collective guidance and encouragement made this process much less arduous than it might have been.

I offer my thanks and gratitude to Emily Custer and Brendah Wekesa, the Nutrition Leads at One Acre Fund, who not only successful advocated for One Acre Fund, a primarily agricultural organization, to take on an increasing number of nutrition programs, but offered themselves as true thought partners in the design of this intervention. Without the tireless work of Marthe Niyonshuti, Daniel Harunashe Matimba and Thierry Hategekimana, the data collection would have been impossible. They helped to hire, train and oversee enumerators, translate surveys and provide continual feedback from the field. There would be no dissertation without their diligent work. Andrew Youn, Matt Forti and Margaret Vernon were the key One Acre Fund leaders who had the faith and confidence in me to allow me the time and resources to see this study to fruition. Eric Pohlman, the Rwanda Country Director, not only approved this study but, at each step, has kept the well-being of Rwandan families at the center of all that he does. Not least of all, I thank the many Rwandan families who sat patiently

with enumerators entertaining their questions so that we might glean some insights from their experiences. I hope the lessons learned here are worth their collective time.

I would not have had the confidence, fortitude or time to complete this dissertation without my loving husband Colin. Colin perpetually lifted me up during my bouts of self-doubt. He pushed me gently to better articulate and refine my ideas during our daily walks, during which he remained genuinely (and inexplicably) interested in the finer points of data analysis and behavior change. He remains my most vocal champion and enthusiastic cheerleader, sometimes to the point of embarrassment, but always with a sincere and supportive love. That love also translated into practical support, and Colin spent countless hours entertaining our children so that I could hole up in a room and write. I could simply not have done this without him. Finally, I thank my two little angels, Caleb and Emmet, who are the loves of my life and give everything else meaning.

Abstract

A Good Egg: An Evaluation of a Social Behavior Change Campaign to Increase Egg Consumption Among Children in Rwanda

Childhood malnutrition, which is endemic in rural areas of low-income countries, leads to a host of deleterious outcomes such as poor cognitive development, worse educational attainment and lower lifetime wages and productivity. However, promoting the consumption of eggs among young children has emerged as a promising strategy to combat childhood malnutrition. Eggs are a convenient and readily available source of animal protein and contain nutrients that promote cell growth and brain development.

Rwanda has high rates of malnutrition, particularly in its rural areas, and despite the relatively common practice of chicken rearing, one of the lowest rates of egg consumption in the world. In this dissertation, I evaluate the impact of two interventions which aim to increase the consumption of eggs among young children, using a difference-in-difference estimation strategy with propensity score matching. In the first intervention (poultry-only), participants of a large agricultural social enterprise purchased Sasso chickens, which are bred to be hearty to rural conditions, on credit, thereby increasing access to eggs. The second intervention (poultry + SBCC) arm layered on a social behavior change campaign (SBCC) of radio messages, limited in person training, text message reminders and posters, all of which aimed to encourage families to feed eggs to children. This campaign was designed based in-depth formative work that identified key motivational constraints to egg feeding. I also included a comparison area, which was supposed to have excluded any similar interventions. However, mid-way

through the data collection, I discovered that this area had a chicken and egg distribution campaign along with an egg promotion campaign, and thus no longer served as an appropriate counterfactual to the two other study arms. Therefore, the primary analysis of interest estimated the impact of the SBCC campaign by comparing the poultry + SBCC to the poultry-only interventions.

I found a relatively modest but statistically significant increase in the number of times per week respondents in the poultry + SBCC arm reported feeding eggs to children of .275 (p=.02) compared to the poultry-only arm. This low impact was possibly due to the rather limited exposure of many respondents to the campaign, as under half of respondents reported having heard the radio campaign at all. This low listenership was a somewhat anticipated artifact of using a community radio rather than the more popular national radio station, which was necessary in order to have unexposed comparison areas. In addition, in-person training and poster distribution was curtailed due to COVID-19 related restrictions. So, while the impact was rather low and unlikely to make a significant difference in nutritional outcomes, it suggests that a higher saturation campaign might achieve even greater impacts.

There were important trends in the types of respondents for whom the behavior change campaign had a greater impact. Respondents who were feeding boys had a much larger impact (.417 increase in egg feeding per week, p=.002) than those who were feeding girls (.138 increase in egg feeding per week, p=.255). In addition, the campaign had a larger impact on those who were already feeding eggs to children (.629 increase in egg feeding per week, p=.004) than those who were not engaging in those practices at baseline (.256 increase in egg feeding per week, p=.002). Future campaigns should

ensure higher saturation of messaging, include specific messaging around the importance of feeding girls as well as boys and could potentially target the easier to reach segment of those who were already occasionally feeding eggs to children. However, the harder to reach non-egg feeders may have greater needs and may also need to be prioritized.

Because the primary outcome of interest in this study (egg consumption among children) was self-reported and prone to social desirability bias, I included a social desirability scale, the Marlowe-Crowne Social Desirability Scale (M-C SDS) Short Form – C, in this study. This study thus also provided an opportunity to validate this scale, which has increased in use in the past decade in Africa, using a large sample of rural East African respondents over two survey rounds. I found that this scale had a low internal reliability across both rounds (alpha<.4), and exploratory factor analysis found that there were five, rather than the commonly found two, underlying constructs. These findings suggest that the M-C SDS Short Form C is not a valid scale for measuring social desirability in rural Rwanda, and possibly other rural areas in Sub-Saharan Africa. Researchers seeking to assess and control for social desirability in these contexts should develop a more appropriate instrument or find other ways to mitigate social desirability bias.

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Chapter 1: Motivation, Background and Methods

Motivation

Despite rather impressive economic growth in recent decades, Rwanda still has some of the highest rates of child stunting in the world, with 33% of children under 5 stunted (NISR, 2020). This problem is more acute in the rural areas of the country where 41% of children are stunted, compared to only 24% of urban children (NISR, 2020). Children are defined as stunted if their height-for-age is more than two standard deviations below the WHO Child Growth Standards median.

Stunting, and malnutrition more generally, is the result of poor nutrition, particularly in the first 1000 days of life, poor access to water and sanitation, and high incidence of infectious disease can also hinder nutritional outcomes (Alderman et al., 2020). Stunted or malnourished children are less able to fight off common childhood diseases such as diarrhea, measles, or malaria, and malnutrition accounts for 45% of all deaths in children under 5 (Black et al., 2013). A large body or research finds that stunting leads to a host of deleterious long term outcomes such as poor cognitive development, worse educational attainment and lower lifetime wages and productivity (Dewey & Begum, 2011; Adair et al., 2013).

Stunting affects brain development by disturbing the proper formation of neural circuits which ultimately results in cognitive deficits and overall poorer educational outcomes (Udani, 1992: Kar et al., 2008; Casale et al., 2014; Adair et al., 2013; Granthan-McGregor et al., 1996). Chang et al., (2002) find that stunted children exhibit more challenging behaviors and perform worse on math, spelling and reading

comprehension, compared to non-stunted peers, controlling for socio-demographic variables. Similarly, a cohort study of children in South Africa found that those stunted at age two performed worse on cognitive tests at age four, controlling for socio-economic status, child-specific characteristics, and home environment (Casale et al., 2014). These cognitive setbacks translate into less overall schooling. Stunted children are more likely to repeat grades and drop out of school, and, overall, complete less schooling (Daniels & Adair, 2004, Martorell et al., 2010). Simply put, a stunted child is unable to achieve their full human potential, which only exacerbates pre-existing global inequities.

In addition to the increased morbidity and loss of human potential, childhood stunting exacts a toll at the macro level through reduced economic productivity due to adults who have lower wages, lower physical and mental capabilities and more work absences (Hoddinott et al., 2013). Researchers estimate that losses from all forms of malnutrition account for up to 11% of GDP in African and Asia each year, exacting a large economic toll in precisely the places which can least afford it (Horton & Steckel, 2013). Addressing childhood malnutrition is part of a key sustainable development goal adopted by all UN member nations; however, major global inequities continue to persist.

Promoting consumption of animal source protein, and eggs in particular, has emerged as a promising strategy for combatting childhood malnutrition. Eggs are a nutritional powerhouse, containing the full stock of nutrients that an organism needs to survive independently. They are a key source of essential fatty acids, which are critical for early brain development, and a nearly complete source of protein (Riediger et al., 2009). Eggs are also considered a near perfect protein source. The protein-digestibility-corrected amino acids score (PDCAAS) is a key way to measure the nutritional quality of

a protein and compares its amino acid composition to what bodies can use. For children 6 months to 5 years, the PDCAAS is 118% compared to 92-94% for meat and fish and only 35-57% for maize, wheat and rice, making it one of the best protein sources available at a relatively inexpensive price (Iannotti et al., 2014). Eggs also contain more choline – a nutrient responsible for cell division and brain development - than almost any other food source (Caudill, 2010; Zeisel & da Costa, 2009). The yolk from one large egg provides 146.9 mg of choline, or 98% of the Institute of Medicine's Adequate Intake for children aged 7–12 months and 73% for children 4–8 years (in Ianotti et al., 2014).

There is also a body of evidence that egg consumption, or the nutrients widely available in eggs, is negatively correlated with stunting. A medical study in Malawi took blood samples from 313 children and found a strong association between stunting and amino acid presence and choline, providing support to the idea that a lack of animal source proteins is a contributor to stunting (Semba et al., 2016). Another study drawing on a sample of over 2500 children up to 23 months old found that a lower consumption of eggs was associated with two-fold increased odds in stunting, controlling for other maternal and child characteristics as well as socio-demographic factors (Aguayo et al., 2016).

In the past eight years, we have seen a mounting body of evidence from randomized trials which demonstrate that increasing egg consumption leads to improvements in child nutritional status, including stunting. This research will be explored in detail in Chapter 3, but in sum, several recent studies have shown that delivering eggs to undernourished children directly or supplying their families with egg-producing hens can reduce stunting, wasting and improve linear growth (Iannotti et al.,

2017, Baum et al., 2017; McKune et al., 2020; Omer et al., 2019). However, some studies had more qualified results and failed to find improvements in linear growth in areas in which stunting was less common and other animal source protein was available (Stewart et al., 2019).

Overall, increasing egg consumption remains a highly promising strategy for improving child nutrition. Eggs have a strong link to child growth, and they are a generally available source of animal protein in rural areas, where stunting rates are highest. The interventions to date, however, have been run on relatively small samples with fairly expensive interventions such as direct daily delivery of eggs or giveaways of poultry. So, there is room to explore mechanisms for increasing egg consumption among more children, at scale, more sustainably. This study tests just such an intervention whereby rural families purchase an improve variety of chicken on credit through a trusted NGO and are encouraged to feed eggs to their children through a multi-pronged social behavior change campaign designed to address their unique consumption barriers. This this chapter I outline the context for the intervention and describe what the intervention entails. I then describe the known barriers to egg consumption and the interventions, including a theory of change. I conclude with a short discussion of the potential contributions to the literature.

Context

Rwanda is a small, mountainous, land-locked East African country, and one of the more densely populated countries on earth. After a devastating genocide in 1994 in which an estimated 800,000 Rwandans were killed by Hutu extremists, the country has made a remarkable recovery marked by solid economic growth and political stability.

Between 2001 and 2015, Rwanda's real GDP growth averaged about 8 percent annually, according to World Bank data, outpacing its neighbors. This economic growth combined with targeted government programming has helped to elevate living standards. By 2013, life expectancy had doubled (Binagwaho et al., 2014) and Rwanda has achieved the highest average annual reduction in both under-five and maternal mortality in the world.[1] These accomplishments are particularly remarkable considering the poor state of the country just after the genocide, when childhood vaccination rates were close to zero (Robson et al., 2019), the childhood mortality rate was among the highest in the world, and foreign assistance for health was the lowest in all of Sub-Saharan Africa (Binagwaho et al., 2014).

This economic progress has been achieved by a strong central government with a clear vision of success and a hierarchical accountability system, which has won praise across multiple sectors (See Robson et al., 2019; Logie et al., 2008; Farmer et al., 2013). One such example is the Community Health Worker program, in which each of Rwanda's over 14,000 villages elect three community health workers who are subsequently trained to deliver preventative and therapeutic interventions at the local level.

Despite recent economic and public health successes, Rwanda remains among the world's poorest countries with persistent malnutrition (Binagwaho et al., 2020). About 62 percent of the population lives on less than US$1.25 per day (USAID, 2017), and most of its 12.5 million inhabitants make their living in the rural areas as subsistence farmers on small tracks of land. According to a 2018 study conducted by the World Food Program,

[1] United Nations Inter-agency Group for Child Mortality Estimation (2020)

over a third of Rwandans are considered marginally food secure, meaning that they are at high risk of becoming food insecure, and food insecurity is higher in the rural areas (WFP, 2018). Nationally, 33 percent of children under 5 years are stunted, and malnutrition rates are even higher in rural areas (NISR, 2020)

A typical family meal in Rwanda consists of a staple component, generally a starch such as cassava or sweet potato, as well as a legume (mainly beans) and/or vegetables. The two components are usually boiled in one pot in a mixed dish and the family eats together (Dusingizimana et al., 2020). I was unable to find data about intra-household feeding norms, but a 2020 study, which relied on both quantitative survey data as well as qualitative data, found that during lean periods, Rwandan families reported that they prioritized the feeding of children aged under 5 years over other household members (Mashingaidze et al., 2020)

Gender norms influence child feeding practices, and gender norms in Rwanda have undergone rapid transformation since the 1994 genocide. Rwanda has traditionally been a patriarchal society in which inheritance passed from father to son, and in which women have had limited rights and opportunities (Jessee, 2020). Similar to many African societies, a Rwandan man's family still typically pays a bride price (generally cattle or money) to the family of the wife, and the wife moves to live with the husband's family (Akukunle, 2007). However, after the 1994 genocide women greatly outnumbered men, and gender norms were inevitably altered, with an increased number or woman-headed households and women taking on more economics and social independence (Akukunle, 2007). The government of Rwanda also accelerated this transition by passing a series of laws aimed at promoting gender equity and inclusion in

political and legal spheres. In 2003, a gender quota system was implemented in Parliament, and today women outnumber men lawmakers in Rwanda, which is currently the country with the highest percent of women in parliament[2] (Burnet, 2019). In addition, the government of Rwanda established a Ministry of Gender and Family promotion and has committed to a gender-based budgeting process that aims to promote gender equity. The government has also officially changed land tenure and inheritance laws to ensure that women have equal ownership of land with their husband when married and have the same rights as men on inheriting land and other assets (Rietveld, 2017). However, these new policies conflict with customary law and norms are slow to change. While women have seen expanded rights in the past few decades, they women still lack equal access to land, and economic opportunity and household economic decisions are still generally made by men (Reitveld & Farnsworth, 2018; Kagaba, 2015).

One Acre Fund, a non-governmental organization, that supplies smallholder farmers training and farm inputs on credit, has a large presence in Rwanda, serving over 800,000 farmers throughout 31 districts in 2021. Starting in 2007, the program has provided farmers with farming inputs (mainly improved seeds and fertilizer) on credit with flexible repayment, input delivery within walking distance of their homes, participatory trainings, and market facilitation to reduce post-harvest losses. One Acre Fund Field Officers operate both as extension workers who conduct regular agricultural training and loan officers, collecting loan repayment.

[2] According to IPU Parline international Global Data on National Parliaments. https://data.ipu.org/women-ranking?month=3&year=2022

The average One Acre Fund client is 46 years old, has a family of 5 and grows a variety of subsistence crops over just under 1 acre of land, on average[3]. Over 50% of these families are moderately or severely food insecure according to the Food Insecurity Experience Scale developed by FAO.[4] The program is available to all farmers in most regions of the country as long as they are able to make a modest pre-payment towards their loan (generally around $5) and have not defaulted on previous loans. Loan sizes average under $30 and repayment rates typically exceed 97%. One Acre Fund, known locally as Tubura, which means "multiply" in the local language, is widely popular in the country, and has ballooned in size from a few hundred farmers in 2007 to over 800,000 in 2021.[5]

In 2020, as part of the agricultural loan package, One Acre Fund offered Sasso dual-purpose chickens on credit in 10 districts, and about 30,000 farm families elected to purchase them. These birds can be used both as laying hens and broilers, and are bred to be resilient to rural conditions and to scavenge for feed, which reduces feed costs and makes the birds more profitable. In addition, 44% of One Acre Fund clients are caring for a child under the age of five, according to One Acre Fund survey data (n=1472). There existed, therefore, a strong opportunity to promote egg consumption for the youngest children among farm families who elected to take chickens on credit and thus had greater access to eggs.

[3] Based on internal One Acre Fund monitoring and evaluation data from 2020.
[4] Based on One Acre Fund survey administered in 2020 with a sample of 1341 enrolled farmers before their harvest.
[5] According to One Acre Fund internal enrollment data

Barriers to Egg Consumption

Rwanda has some of the lowest egg consumption per capita in the world. According the National Institute of Statistics in Rwanda (NISR), on average, Rwandans eat about 13 eggs per year (2016 data), compared to an average of 36 eggs per year in all of Sub-Saharan Africa and over 270 egg per capita per year in the US[6].

Initial research (further detailed in Chapter 4) has uncovered several barriers to egg consumption among rural Sub-Saharan African children. First, in many low-income countries, the price for eggs per calorie is dramatically higher than it is for cheaper and more widely available cereals, and the access to eggs (either on farm or in markets) is uncertain. For example, in high-income counties, egg calories are 2.3 times as expensive as the cheapest cereal in the country. However, in sub-Saharan Africa, eggs are 9.5 times as expensive as cereals, meaning that those who need animal source protein the most are least able to afford it (Morris et al., 2018).

The problem of low egg consumption is also partly due to low egg production, and Rwanda ranks among the lowest countries in terms of egg production. In low-income countries, the majority of poultry production happens in rural farms with small flocks of under 50 birds (Gilbert et al., 2015), and these producers are beset with multiple structural and environmental challenges. They struggle with poor access to vaccines and veterinary services, high feed prices, disease, and predation; and the poor infrastructure, weak access to financing and undeveloped distribution networks prevent small producers from scaling successfully (Wong et al., 2017). Low production increases the prices,

[6] USDA, World Agricultural Outlook Board, *World Agricultural Supply and Demand Estimates*, using statistics from U.S. Department of Commerce, Bureau of the Census; U.S. Department of Commerce, Bureau of Economic Analysis; USDA, National Agricultural Statistics Service; and USDA, Economic Research Service.

making eggs an expensive luxury item for most rural smallholder households. One-third of all Rwandan households raise chickens (NISR, 2018), but even among those who do so, there is great temptation to sell eggs to pay for other calorie dense food. To quote one farmer we interviewed as part of our formative research, "Each and every egg the people see as money, not as good food for them. Therefore, they prefer to sell them to get money to use in other family needs rather than eating them."

Second, despite being well versed in the nutritional benefits of eggs for their children, Rwandans do not place much value on feeding them to their children. According to initial research for this dissertation (in depth interviews with caregivers of young children), Rwandan families understand and are able to well articulate the nutritional benefits of feeding eggs to children, citing their benefits on overall child health, growth and even cognitive development. Some African countries have cultural taboos expressly prohibiting or discouraging the consumption of eggs. For example, in Southeastern Nigeria it is thought that feeding eggs to children too early will predispose them to stealing later in life (Ekwoci et al., 2016) and are taboo for young girls in Lesotho where it is thought to lead to an increased sexual desire (Gay, 2010). However, initial research has shown that there are no such pervasive taboos among rural Rwandan farmers. Still, despite the lack of taboos and relatively widespread understanding of the benefits of eggs, there is a lack of perceived value in feeding eggs to children. To quote one interviewee, "It's not because I couldn't get him eggs; but because I don't think they are that necessary."

In addition, a third factor potentially affecting low egg consumption is present bias, in which benefits far in the future are highly mentally discounted, which might be

preventing caregivers from feeding children food which could aid in their cognitive development and subsequent success in school. Cross-cultural research has shown that people across different cultures differently value future benefits and that African tend to be more present-biased than other cultures (Wang, et al., 2011). In addition, those living under the stress of poverty are also more present-biased in their decision-making (Hausofer & Fehr, 2014). In the initial research, caregivers professed a profound interest in the educational attainment of their children as the pathway to escape poverty. However, the benefits are quite distant and perhaps a bit uncertain, but the present costs are significant. While parents may know that regularly feeding eggs will help their child grow and thrive, those benefits are far off in the future and families may have more immediate concerns.

A final factor arises from salience or habit. In Rwanda, there are a few staple meals, generally consisting of maize, beans, rice, cassava, and bananas, and some have noted the narrowing of the food plate in Sub-Saharan Africa towards calorie-dense staples (Noack & Pouw, 2015). So, it may be difficult to break out of the habit and expectation of typical staple meals. In addition, women, who generally do most of the meal preparation in Rwanda are particularly time burdened, which makes any change in habit more costly. A study of time use data in Rwanda found that while women spend slightly less hours per week on market-related activities than men (21.4 vs 26.1), they spend vastly more time on domestic activities such as household chores, childcare, and cooking (23.5 vs 5.2) (Habimana, 2017). The time burden on women may raise the psychological costs of any additional tasks or change in routine. A mother may be quite

convinced of the importance of feeding eggs to their children and even have the means, but may still struggle to build it in to her routine as a habit.

Overall, the solid educational foundation and lack of countervailing taboos lays a solid foundation for encouraging increased egg consumption. However, the remaining obstacles of expense, perceived value, present bias and habit are noteworthy.

Intervention Description in Brief

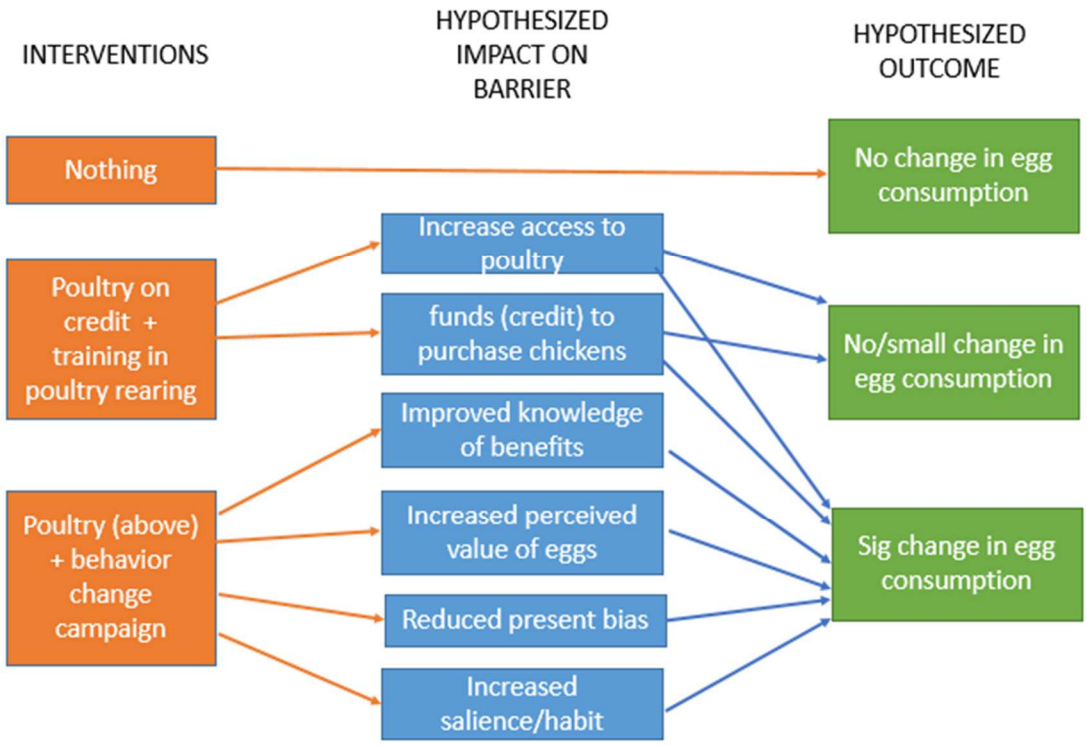
For this study, the intervention consisted of two arms, a poultry-only arm and a poultry + social behavior change campaign (SBCC), to test the most cost-efficient way to achieve the greatest impact. The poultry-only arm included farmers who were provided Sasso chickens on credit as well as training on poultry raising, but who did not receive the social behavior change campaign. The poultry + SBCC arm consisted of poultry on credit and training plus a community radio campaign emphasizing the benefits of feeding eggs to young children, limited in-person training from One Acre Fund field officers, a poster to hang in the home with the message that "Eggs are precious, and so is my child" along with the image of a mother lovingly looking at her young child eating eggs, and text message reminders. As noted above, early qualitative work found that Rwandan households understand the benefits of eggs and do not generally hold any countervailing perceptions about any harms of consuming eggs. However, the greatest barrier to feeding children eggs seems to be in valuing them enough to justify the costs. Therefore, the behavior change campaign focused on increasing the perceived value of feeding eggs to children.

The key messages centered around the following themes which were identified after qualitative work with families.

- Eggs are an investment for the future, child growth and cognitive development.
- Eggs are a key part of educational success.
- Eggs are a superfood with more protein than more expensive foods and a special nutrient. which helps in brain development.
- Eggs are a quick and easy way to give your child energy.
- Feeding eggs to children as an aspirational source of pride/ indicates success as a farmer.
- Eggs are expensive, but investing in your children makes it worth the expense.

The two intervention arms test different change pathways. The poultry-only arm assumes that improving access alone can achieve an increase in egg consumption among small children relative to families who lack similar access. The poultry + SBCC intervention assumes that access alone is insufficient and requires a campaign to make the increase the perception of benefits. Figure 1.1 Displays the hypothesized pathways for each intervention.

Figure 1.1: Hypothesized intervention pathways



Contribution to the Literature

The results of this study have the potential to contribute to the canon of knowledge across several spheres. The promotion of egg consumption as a specific intervention to fight malnutrition is a rather new intervention idea that has garnered considerable attention and excitement. However, many of the studies which provide evidence of nutritional impacts relied on small samples, with fairly intensive interventions. Given the scope and geographic spread of the problem of malnutrition, it is important to investigate the impact of programs which have the ability to reach a large number of malnourished children at scale, and this study attempts to do just that.

The Global Alliance for Improved Nutrition (GAIN) is currently undertaking an impact evaluation of a mass marketing campaign to promote egg consumption in Nigeria, but these results are not yet available. The intervention in Nigeria is a multi-pronged mass media and community effort including radio spots, television spots, community fairs, school fairs, household prizes and point of sale marketing. However, the consumer wallet is larger in Nigeria, and the focus is therefore more on buying eggs than rearing chickens. This study results will have lessons for how to scale up an egg consumption promotion campaign in a more resource-poor environment and with consumers who are primarily feeding children with eggs their own children

Secondly, this study will provide robust evidence for the impact of a mass media campaign. Several systematic reviews have noted the lack of rigorous evidence about what works in mass media for behavior change in nutrition (Naugle, 2014; Higgs et al., 2014). Many available studies include only post-intervention analysis which examined program impacts by comparing those who had high vs. low exposure to the campaign.

However, in this type of research design it can be difficult to control for the considerable selection bias effects and recall of exposure can be conflated with behavior change. Specifically, it can be difficult to discern whether exposure to a marketing campaign leads to behavior change or the behavior change induces the self-report of exposure. The design of this study helps mitigate this by measuring that change over time of both families within the mass media catchment area and of those in a similar area which is not exposed to the mass marketing campaign.

Finally, as will be described in the methods section, a unique feature of this study is its attempt to address and control for social desirability bias (SDB). Because behavior change campaigns are sometimes designed to alter a behavior that is not easy to observe or measure, there may always be some component of self-reporting in evaluating these programs. This can be highly problematic when the behavior change is seen as desirable and the social incentives to claim compliance are high. If reporting bias is not taken into consideration, evaluations of effectiveness may be over-estimated and policy responses will not accord with reality. Until now, the most commonly used psychometrics scale to control for SDB in studies of African populations is the Marlowe-Crowne scale. However, it has not been validated over large samples, and generally has been used to estimate SDB for younger or more educated respondents. This study will shed light on how effectively this scale can be to estimate and control for SDB in rural African populations.

Chapter 2: Methodology

In this chapter I outline the methodology for assessinweg the impact of the egg promotion interventions. I start with the research question and describe the study location in Rwanda and the program which implemented the interventions – One Acre Fund. I then describe the sampling strategy and outline the ethical approvals process. Finally, I describe the challenges that arose during data collection, some of which were foreseen and others of which came as a surprise.

Research Questions

The research questions for this study are as follows: (1) What were the impacts of the poultry-only and poultry + SBCC interventions on knowledge, perceived ability and childhood egg consumption? (2) What was the impact of the SBCC intervention on those who had higher exposure to the campaign? (3) Which sub-populations were most effected by the intervention? (4) How does social desirability affect the self-reporting of egg consumption and does this bias mitigate program impact?

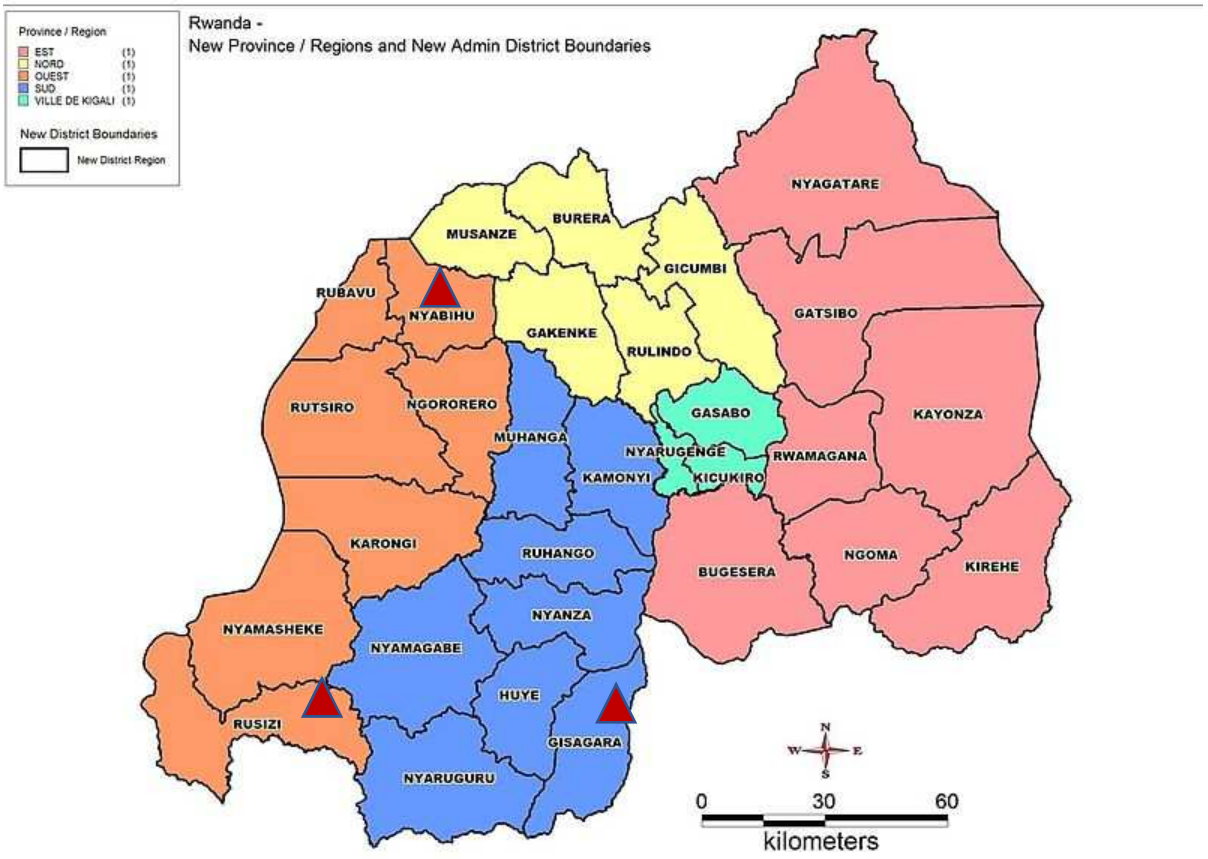
Trial Design and Location

Because the radio campaign relied on a community radio station (Radio Salus), I was unable to randomize at the individual or even community level. Instead, I compared three districts, one of which received the full SBCC intervention in addition to the poultry on credit plus poultry training, the other of which received only the poultry intervention, and finally a third district to serve as a pure comparison district. All respondents were One Acre Fund farmers who self-selected into the program, so the results will be generalizable to that population. I chose Gisagara district as the poultry + SBCC arm

because it was a large district with relatively typical poultry adoption, and there was a community radio station with reportedly high listenership. At the time of study design there was limited data on listenership among community radio stations. The One Acre Fund Radio department had some data showing that radio Huye had the highest listenership in the area, but the baseline data for this study found that Radio Salus had higher listenership, so I elected to work with Radio Salus.

To the extent possible, given the data available, I matched the poultry-only and pure comparison districts with the poultry + SBCC district on important characteristics, such as population density, poverty levels, and average number of chickens adopted, for the two poultry arms. However, I was limited because I had to exclude all districts in the community radio catchment area and had to draw from only four remaining poultry districts. From these I chose the district which was closest in terms of average poultry adopted by enrolled farmers, overall poverty levels, education levels, and household size, and distance to the capital city of Kigali. Employing these criteria lead to the selection of Rusizi district for the poultry-only arm. For the pure comparison area, I had to select a One Acre Fund district which was not running any other trials, as that would have altered the type of farmer induced to join the program, and which was also out of the radio catchment area. This left only four districts to choose from. I matched on the same characteristics noted above and selected Nyabihu district as the pure comparison (See Figure *2.1* for study locations). I confirmed with One Acre Fund program staff operating in each area that there were not similar poultry or egg promotion campaigns planned by the government or other NGOs over the study periods in any of these areas to the best of their knowledge.

Figure 2.1: Map of Rwanda with study locations



The estimation strategy is a difference-in-difference with propensity score matching. While I cannot rule out the existence of omitted variable bias or location effects, assuming there are parallel trends in our outcome of interest, egg consumption, I can feel fairly confident that we can achieve an unbiased estimate. While I don't have exact historical data on which to assess these parallel trends, due to the historically low egg consumption throughout Rwanda, I did not have strong reason to believe that any one study area would exhibit divergent trends over the study period. However, this is certainly a limitation of the study design.

Sampling

I aimed for a sample of 800 families[7] in each arm. Sample size estimates were calculated based on the minimum sample size needed to detect a statistically meaningful difference between the poultry-only and pure comparison groups, with the understanding that this is likely to be the smallest effect size between any two groups of interest. Due to the lack of internal data on possible effects size, I relied on external data from an evaluation of a similar model. The similar model was evaluated in a recently published study which evaluated a program in Ethiopia which also had two trial arms: 1) genetically improved chickens + training and 2) first arm + nutrition-sensitive BCC as well as a control group (Passarelli et al., 2020). These authors found that eggs per week consumption was .3 for controls, .6 for treatment 1 and .8 for their higher touch intervention. The evaluation in Ethiopia found a much lower impact than two other similar studies in Burkina Faso (McKune, 2020) and Ethiopia (Omer, 2019), so provides a conservative estimate of anticipated impact. Given the rather low rates of egg consumption in Rwanda and the hypothesized low level of egg consumption increase without any behavior change encouragement, I conservatively assumed that the poultry-only arm would achieve an increase of .2 egg per week compared to the pure comparison group. I assumed an *alpha* of .05, a *Beta* of .8 and attrition of 20% between baseline and endline to achieve the sample of 800 per group.

I employed random sampling of eligible farmers in all three districts. In Gisagara and Rusizi (the poultry districts), I identified all farmers who had confirmed purchasing chickens from One Acre Fund and also reported to their One Acre Fund Field Officer that

[7] A family is defined in the surveys as the group of people who share meals most days of the week.

they were caring for a child under 5 years of age. This left 1,378 households in the poultry-only district (Rusizi) and 2,520 households in the poultry + SBCC district (Gisagara). For the pure comparison areas (Nyabihu), I randomly selected from all 8,033 One Acre Fund farmers who had children five under in their care. All random selection was done using a random number generator in Excel. One Acre Fund maintained updated lists of farmers in all areas which will made the random selection fairly straightforward. I ultimately reached a sample of 2299 respondents, who were reached both in the baseline and the endline surveys (769 in the poultry + SBCC district, 750 in the poultry-only district and 780 in the comparison district).

Data Collection and Survey Instrument

The first round of data collection, hereafter referred to as the "baseline survey" took place in all districts in May 2021 (See Appendix A). The collection was completed before any SBCC activities began. Families who had purchased chickens through One Acre Fund in Gisagara and Rusizi had already received their chickens. However, none of these chickens would be laying eggs until July, at the earliest. So, the main pathways for program impact were not yet activated at the time of the first round of data collection. The primary respondent for data collection was the person in the family who was most responsible for food consumption decisions of children under 5 years old.

The baseline and the endline survey included questions on basic demographic characteristics (e.g. age, gender, household size, marital status, education level, and land size), beliefs and practices around egg production and consumption and the consumption foods including animal source proteins, among children under 5 in their household. Acknowledging that self-reported data are subject to social desirability bias, I used

several mitigation strategies. First, consent to the survey noted the intention was to gather information on feeding practices and nutrition knowledge more generally, rather than on the egg promotion campaign specifically. The survey also included questions about egg consumption as part of a larger module examining overall diets of multiple food groups. Finally, the survey included a social desirability bias scale (the Marlow-Crowne social desirability scale, short form C) which had been validated for use in similar contexts and to be used as a statistical control variable (Vu et al., 2011). The Marlowe-Crowne social desirability scale (MC-SDS) short form-C consists of 13 statements (e.g. "I am always courteous, even to people who are disagreeable"), which respondents either agree or disagree with (Reynolds, 1982). These statements are generally things which are socially desirable but uncommon, or socially undesirable but more common. The items are scored whereby a 1 indicates a socially desirable response, and a 0 indicates the opposite and totaled across all questions. A higher total score indicates a higher propensity to engage in social desirability bias.

The endline survey also included questions assessing the degree of exposure (e.g. how many times they received a text message or heard a radio spot) and questions which will help refine the behavior change strategy in the future (e.g. which radio characters did they remember most? Why did they start feeding eggs to their children?)

All survey questions were piloted and revised for clarity after feedback from enumerators and respondents. All questions were written in English and then translated into Kinyarwanda and then back-translated, by a different translator, into English and checked for consistency of meaning. The survey was coded into an online platform (Commcare) and administered through electronic tablets. The survey coding enforced

skip patterns and applied validation conditions to reduce enumerator error. Ten percent of surveys were back-checked, a process whereby supervisors re-administer a portion of the survey to respondents and then compare responses with the original survey to ensure quality. Field supervisors also conducted in-field supervision of enumerators to ensure that they are administering the surveys according to the training guidance. Finally, survey duration and GPS data were analyzed as a quality control measure.

Ethical Concerns and IRB Approval

While there is considerable evidence of the benefits of egg consumption among children, it is important to also examine the evidence of any risks, threats or harms to encouraging egg consumption and poultry rearing. Headey and Hirvonan studied the trade-off between increased exposure to poultry feces (a risk factor for diarrhea and respiratory infections, which affects child linear growth) and increase consumption of eggs, which is associated with positive growth (Headey and Hirvonan, 2016). Drawing on a large survey of rural Ethiopian households they find positive association between poultry ownership with child height-for-age Z scores (HAZ), but a negative association with HAZ among those who corral poultry in the household dwelling at night. This suggests that training on livestock practices and sanitation practices are crucially important. The poultry training includes such messaging.

There is limited evidence of egg allergies in Sub-Saharan Africa, due to the paucity of studies and the reliance on self-reports. (Kung et al. 2012). However, one study run in the Eastern Cape of South Africa which used pin prick tests found that only 0.5% of rural Black South Africans had an egg allergy. Interestingly, these rates were much lower than for urban Black Africans (Botha et al., 2019).

Even US researchers are reconsidering the risks of early egg consumption. Before 2008, the American Academy of Pediatrics (AAP) advocated the delayed introduction of eggs until the age of 2. However, based on more completed and updated research showing that the introduction of allergenic foods into the infant diet was actually likely to reduce the likelihood of sensitization, the AAP reversed these guidelines (Wall, 2019). In addition, while the high cholesterol in egg yolks have been commonly thought of as a public health concern, recent evidence has contradicted this belief. (Zampelas, 20 12)

This study was approved by the George Washington University Committee on Human Research, Institutional Review Board, (IRB# NCR213380) as well as the Rwanda National Council for Science and Technology Institutional Review board (RP00000093). Both survey rounds were also provided survey approval by the Rwanda National Institute of Statistics. All face-to-face interviews were conducted respecting the Ministry of Health guidelines pursuant to COVID-19, and enumerators were social distanced, conducted the interview outside, when possible, and fully masked.

Analysis

I employed a difference-in-difference estimation strategy to estimate effects of the various interventions on egg feeding. The estimation strategy is a difference-in-difference estimate as follows:

$$\Upsilon_1 = \alpha + \beta \mathrm{T}_i + \gamma t_i + \delta\,(\mathrm{T}_i * t_i) + \varepsilon_i$$

Where:

Υ is the outcome
α is the constant term
β is the treatment group specific effect (to account for average differences between treatment and comparison)

T is a binary variable indicating whether the participant received the treatment or not
γ is the time trend common to treatment and comparison groups
t is binary time variable with 0 indicating a baseline observation and 1 indicating a endline observation
δ is the true effect of the treatment
ε is random error (random component of the linear relationship)

For the change in knowledge, I estimated the percent of farmers who moved from not strongly agreeing to strongly agreeing with the following statements: "Eating eggs regularly improves the health of young children," "Eating eggs regularly improves the brain development of young children," "Feeding young children eggs is a good investment that will improve their school performance when they start school" and who move from not strongly disagreeing to strongly disagreeing with the statement, "Eating too many eggs can give too much protein to children and is bad for their development." Baseline knowledge was already quite high among all groups, and that is why I looked for increases in the intensity (i.e. *strongly* agreeing) with the knowledge statements.

To assess changes in attitudes, I estimated the percent of farmers who moved from not agreeing or strongly agreeing to agreeing or strongly agreeing with the following statements: "I am confident I can reserve some of the eggs we produce so my young children can eat them", "I am confident I can buy some eggs so my young children can eat them," and "I am confident I can feed my young children eggs at least twice per week."

For the primary outcome of interest - changes in egg feeding behavior – I ran the OLS regression described above with reported weekly egg consumption as the dependent variable and a dummy for time (0=baseline, 1=endline) and treatment status (1=treatment, 0= comparison) and an interaction term of time*treatment, which produced

the difference-in-difference estimate. I conducted this analysis three times comparing (1) the SBCC+poultry to the poultry-only (to isolate the additional impact of the SBCC) (2) the SBCC+poultry to the pure comparison group (to estimate the impact of the full intervention) and (3) the poultry to the pure comparison (to estimate the impact of providing poultry on credit only).

In addition to presenting the DiD estimates, I also estimate the DiD estimates adjusted with propensity score matching. Propensity score matching allows us to match groups on observable characteristics to try and minimize any differences between groups. I matched the treatment and comparison group in each analysis on gender, number of cows, land size, marital status, educational status, age of respondent, ubudehe (wealth) status, household size, whether the household had a phone and the age of the child, all of which had differences at baseline between the groups and/or I had reason to believe would affect the outcome and were unlikely to be affected by the treatment. For example, I found some meaningful differences at baseline in number of phones, number of cows and land size, all of which can be considered wealth proxies that correlate with egg consumption, so I included those covariates in the matching algorithm. I used a nearest neighbor matching strategy with replacement because the comparison sample was not much larger than the treatment samples in all three comparison models. Finally, to control for the effect of social desirability bias, I ran the above analysis but also matching on the Marlowe Crowne Social desirability scale. See Table 2.1 for a summary of the estimate models. I consider the finding robust if there are low p-values across all model specifications.

Table 2.1: Summary of models

Comparison	Rationale	Specification		
		DiD	DiD+ PSM	DiD + PSM + Controls for MC-SDS
SBCC+Poultry vs. Pure Comparison	To estimate impact of the full program	X	X	X
SBCC+Poultry vs. Poultry-only	To estimate impact of the SBCC component	X	X	X
Poultry-only vs. Pure Comparison	To estimate impact of the poultry component	X	X	X

Not all respondents in the poultry + SBCC arm had equal exposure to the SBCC campaign. Some may have attended training, heard multiple radio messages and hung the poster in their homes. However, others may have had relatively little interaction with the campaign. The estimate of impact, however, is average treatment on all of those who were intended to be treated (intent to treat effect, or ITT). Policy makers might also want to know the impact on those who had more complete exposure to the campaign. This is challenging because the SBCC program is multifaceted and prone to spillovers. Any given participant could have received any combination of direct training, exposure to the radio spots, text message reminders and receiving and hanging a poster. In addition, over half of those who heard the radio campaign (51%) reported discussing it with their friends and neighbors. So, there is no clear delineation of those who were treated and those who were not. Even so, I attempt to investigate the trends among those who had various levels of exposure to the behavior change campaign. I estimate the change in poultry consumption from baseline and endline within the poultry + SBCC arm, controlling for gender, marital status, number of cows owned, education, age, wealth status and household size, for the following groups: (1) those who heard the radio campaign, have a poster hanging *and* attended a training; (2) those who heard the radio

campaign *or* had a poster *or* attended a training, (3) those who heard the radio campaign, (4) those who had a poster hanging, (5) those who attended a training. These are pre-post changes with no comparison group so the estimate should be considered suggestive trends rather causally estimated.

For the analysis on heterogeneous effects (subgroup impacts), I hypothesized that the impacts could differ by the wealth status, because those who are wealthier are more likely to be able to act on the message of encouragement and feed their children eggs. I created a wealth index using principal components analysis, which included assets, land size, ubudehe status and education, and created a binary wealth variable cut at the median of this index. I also hypothesized that the behavior change campaign might be more effective for those who were already feeding some eggs to their children at baseline. This expectation was because I suspected that it is easier to convince families to increase the level of egg consumption among those who were already feeding eggs, rather than convincing families to undertake an entirely new activity. Thirdly, I hypothesized that impacts could differ by education level as those with higher education are more likely to absorb information from training (both in-person and radio messages). Finally, I was interested to see if the intervention was differentially effective for children depending on their gender. In many cultures, boys are given better and more food relative to girls. Preliminary data on dietary diversity to not find any differences based on the gender of the child, but these differences might emerge for more precious or expensive foods. I present the results of the difference-in-difference analysis for each subgroup; however, I did not attempt any propensity score matching due to the reduced sample size for this subgroup analysis. In order to estimate heterogeneous effects of the program

interventions, I ran the DiD regressions including an interaction term between treatment and subgroup status.

Challenges and Limitations

There are several challenges and limitations to this analysis. Some were anticipated, and so I was able to modify the design or data collection to address these challenges. Others were unanticipated and so I had to modify the analysis or interpretation to account for them. The anticipated challenges are delineated in Table 2.2 below. For example, I anticipated that exposure to the radio program would be quite low, and this was indeed the case. Baseline survey data found that 84.2 % of respondents listened to Radio Rwanda as their first or second choice and only 18.5% listened to Radio Salus as their first or second choice. However, Radio Salus was still the most preferred radio station in the poultry + SBCC district (Gisagara), other than Radio Rwanda. I attempted to increase the likelihood that participants heard the radio campaign by sending text message reminders of the content and times of the radio spots. It is very likely that we could have vastly increased the reach of the radio campaign if we had worked with Radio Rwanda; however, because Radio Rwanda has a national reach, this would have impeded our ability to establish any credible counterfactual. The unfortunate downside is that radio listenership was greatly limited.

Table 2.2: Anticipated study challenges and mitigation strategies

Research Question	Challenge	How addressed in design?
What were the impacts of the poultry-only and poultry + SBCC interventions on knowledge, attitudes and childhood egg consumption?	Social Desirability can affect responses about # of eggs consumed.	• Survey introduction partially obscured the focus on egg consumption, by describing this more broadly as a "nutrition" study. • Consumption of eggs was embedded in a larger module about consumption of multiple food groups. • Collected data about social desirability through the MC-SDS and control for this in analysis
	Community radio has relatively low listenership relative to national radio station	• Sent text message reminders to listen Radio Salus egg programing at the times the spots would air. • Trained field officers to remind families to listen to radio Salus.
	The three study arms do not exhibit parallel trends in terms of egg consumption	• Obtained Demographic and Health Surveys to examine egg consumption trends in the 3 districts.
	The pure comparison and poultry-only arm do have any exposure to egg consumption campaigns.	• Worked with One Acre Fund staff who have a presence in all 3 districts to confirm if there are similar campaigns in the non-SBCC districts.
Which sub-populations were most affected by the intervention?	Possible that the sample size is not large enough to detect differences between these groups.	• Divided the sub-groups at the median (e.g. above median family size vs. below median family size), rather than estimating the impact by fewer categories.
How does social desirability affect the self-reporting of egg consumption and does this bias mitigate program impact?	For social desirability bias Translation and implementation. These are quite nuanced questions and there is possibility for respondent confusion.	• Translated and back-translated the Marlowe Crowne questions and dedicated extra time during enumerator training.

There were other challenges which materially affected the study design and were not fully expected (See Table 2.3). The biggest challenge was that, despite an early investigation of this possibility, the pure comparison area (Nyabihu) did, in fact, have an egg promotion campaign, which only came to our attention at the end of the study. Just after our baseline was conducted, the Hinga Weze program, a 5-year, $32 million USAID-funded project focused on food systems and nutrition, started distributing chickens to families in Nyabihu and working closely with sectors and community health workers to mobilize vulnerable/poor families to feed eggs to their children. In addition, they began a campaign to donate eggs to families with children under 2 years of age in some sectors of Nyabihu. Hinga Weze had started programs in 2018 and had not done such a campaign in the past, instead focusing on iron-rich beans, orange-flesh sweet potatoes and other crops, so this came as a surprise to us. In addition to the Hinga Weze program, another program, the Sustainability Agricultural Intensification and Food security Project (SAIP), funded through the World Bank, initiated a similar campaign of chicken distribution and mobilization activities to encourage families to feed eggs to children in Nyabihu. Previous to this, the work under this project in Nyabihu had been focused on improving potato cultivation and value changes, so, again, this poultry program came as a surprise to us. It's possible that the excitement around the potential of early egg feeding has reached a critical point, so that agricultural programs with nutrition goals are keen to incorporate this strategy.

I had initially worked with the One Acre Fund Government Relations team to assess if there were other poultry distribution or egg promotion campaigns in our areas, but nothing was uncovered at that time. This is a violation of the study design and means

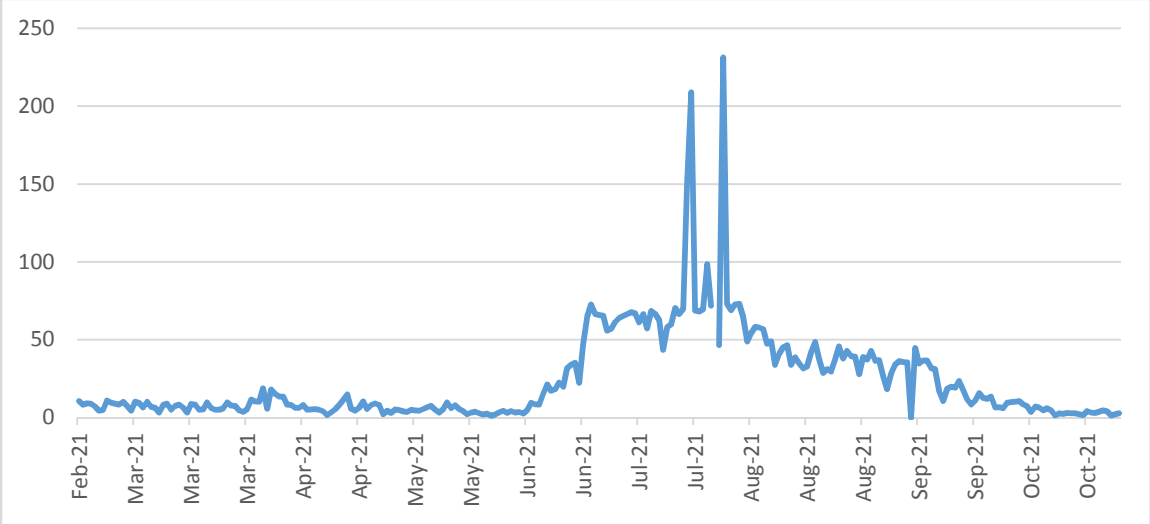
that there is no “pure” comparison area with which to test our theory of change. Henceforth, I refer to this group as the “compromised comparison” group. For transparency's sake, I present the trend and outcome data from this compromised comparison district, but the interpretation of the analysis will account for this fundamental challenge in study design.

Excluding the compromised comparison area leaves us with the primary comparison between the SBCC + poultry arm and the poultry-only arm, a comparison which estimates the impact of the SBCC intervention only. This is not a fatal flaw. The behavior change campaign was the primary innovation of this study, which resulted from in-depth formative research, and has not been examined by other researchers at this scale to date. Therefore, we can still realize policy-relevant insights from the impact of the behavior change campaign compared with the poultry-only arm.

The other important unexpected challenge was that COVID-related restrictions hampered the One Acre Fund field team’s ability to conduct egg promotion trainings and to deliver egg promotion posters. During study planning, COVID cases were relatively low and intra-country travel restrictions had been lifted. However, when the SBCC intervention was slated to begin in June of 2021, COVID cases began rising (See Figure 2.2 Below), and One Acre Fund, in accordance with the Government of Rwanda’s policies, greatly curtailed any group meetings. One Acre Fund could not conduct in-person training of the 59 field officer trainers, and instead trained them virtually in small groups. One Acre Fund supplied the field officers with talking points and picture books for training (see Appendix C) as well as a list of chicken adopters who had children under five, and instructed them to conduct one-on-one training as part of poster distribution.

While theoretically, one-on-one training has the ability to be more effective, field officers were not able to train all eligible families and each training was greatly shortened due to time constraints. In addition, egg promotion training was one of many tasks that One Acre Fund field officers had among their overall duties, which included collecting repayment on One Acre Fund agricultural loans and other agricultural training. Therefore, adherence among field officers was very poor, and only 40.5% of respondents reported receiving any training at all.

Figure 2.2: Number of confirmed COVID-19 cases per million people in Rwanda



Source: COVID-19 Data Repository by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University

COVID-related restrictions also affected the distribution of egg promotion posters. I had anticipated that poster distribution would occur during the egg promotion training between farmer groups and field officers. However, as noted above, these meetings were not held in person and field officers instead strove to meet each participant separately in their homes. Not all field officers managed to complete this task due to competing priorities, and only 71% of intended recipients received the poster. The relatively minimal overall exposure to the SBCC, through radio, posters, text messages

and in-person training, means that any impact we find should be considered a floor of potential impact rather than a result of a fully implemented program.

Table 2.3:Unanticipated study challenges and how they were addressed

Research Question	Challenge	How addressed in analysis / interpretation?
What were the impacts of the poultry-only and poultry + SBCC interventions on knowledge, attitudes and childhood egg consumption?	Comparison area had a similar egg promotion campaign	• Present all planned estimates; however, consider the comparison group a "contaminated comparison" group, and mainly draw on the SBCC + poultry vs. poultry-only for conclusions and recommendations.
	COVID restrictions prevented field officers from conducted in person group training	• Results presented can be considered a lower bound of potential impact from a fully implemented campaign.

Note on Statistical Significance Reporting

In 2016, the American Statistical Association released a statement summarizing years of debate on the use of statistical significance testing, and concluded that the p-values were widely misused, misunderstood and misinterpreted (Wasserstein & Lazar, 2016). The statement, based on a consortium of over two dozen experts, urged that scientific conclusions and policy decisions be based not on whether an estimate passes a certain p-value threshold, and instead be based on a more holistic assessment of what prior studies have found, the soundness of the study design, the sample size and the size of the effect in relation to benefits, risks and costs. They warn against the practice of "p-hacking," whereby a researcher conducts myriad statistical tests, but selectively reports whose which are statistically significant as determined by conventional thresholds (e.g.

<.05), and they patently reject the false authority conferred by a dichotomous test of significance.

In 2019, the journal American Statistician built on this consensus and argued that researchers jettison the terminology "statistically significant" and "non-significant" entirely, as this dichotomy is more authoritative than is often warranted (Wasserstein et al., 2019). They recommend reporting all p-values and using scientific reasoning, rather than simply comparing the p-value to a set value, to interpret results, and that accepting the inherent uncertainty of inferential statistics will help researchers seek better designs, more accurate measures and larger samples.

In yet another signal of an emerging scientific consensus, in 2019, the highly regarded journal *Nature* published an article, with over 800 signatories, highlighting problems of using "statistical significance" thresholds and concurring with the ASA recommendations (Amrhein et al., 2019). The authors decried a pervasive misunderstanding of the conclusions of statistical significance tests, finding that about half of journal articles reviewed (n=791) falsely report non-statistically significant results as having "no effect." They too argue that researchers should present p-values, but not use dichotomous or even categorical thresholds for interpreting results.

Therefore, in presenting the results I will refrain from using the terminology of "statistically significant" and instead present all associated p-values. I will interpret the results based on how robust the findings are across multiple specifications and consider the effect size given the theory of change and potential nutritional benefits.

This study design benefits from a much larger sample size than previous similar studies. However, the difference-in-difference study design cannot fully address omitted

variable biases as can a fully randomized trial, and the parallel trends assumptions cannot be fully assured based on available data. In addition, while I do attempt to control for measurement error (specifically, social desirability bias), I am relying on often imprecise self-reported data. Taking all of this into consideration, when a finding meets the criteria of low p-value across multiple specifications, I will term it a "meaningful" result.

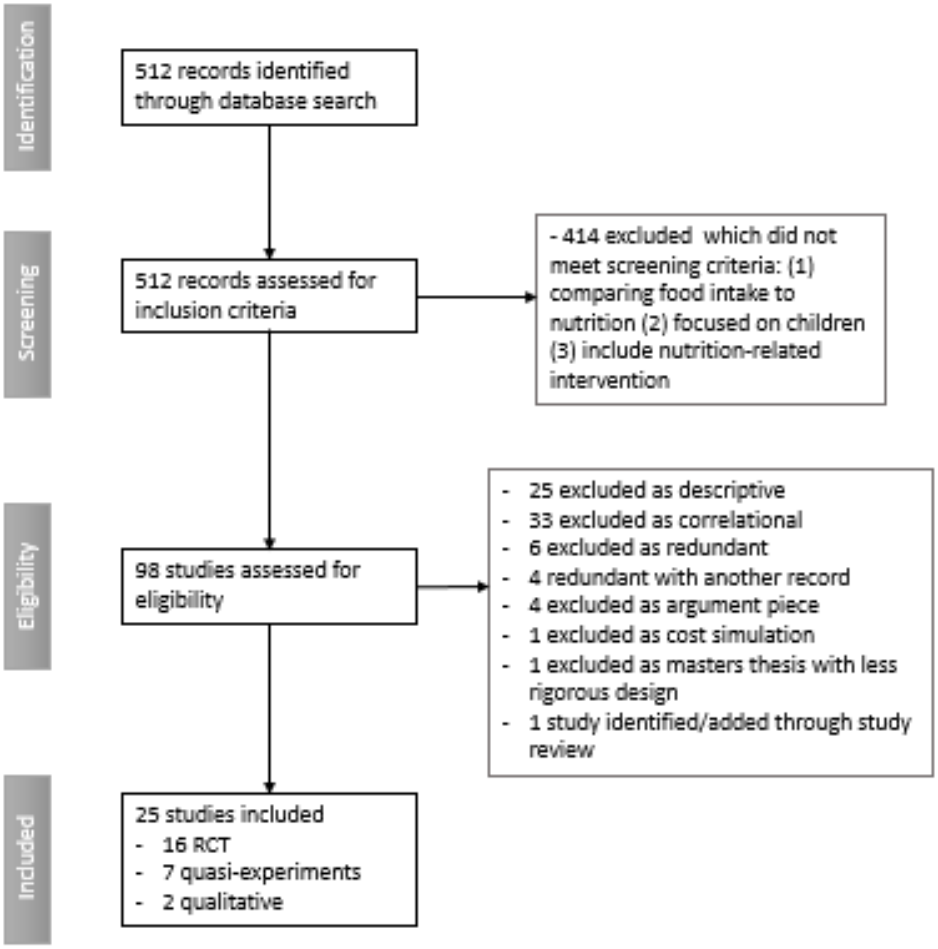
Chapter 3: Literature Review

In this chapter I present a systematic literature on the impact of intervention to promote egg consumption among children. I first present the process by which I selected the studies. I then present the results categorized by the type of intervention: direct provision of eggs plus behavior change, studies which compared a poultry give-away arm with a poultry plus behavior change campaign (similar to this study), direct provision of eggs in more clinical settings, intervention focused solely on poultry and finally complex interventions for which egg consumption promotion was only one part. I then describe the themes across all studies reviewed and the remaining gaps in the literature which I hope this current study can help to address.

In order to put this study into the proper context, I undertook a systematic literature review of studies that focus on the impact of egg promotion campaigns on childhood nutrition. I used a review process as outlined by Petticrew and Roberts, in which the reviewer clearly defines the research question, determines the type of studies required and assesses them based on inclusion criteria, critically appraises the included studies, and then synthesizes and disseminates the findings (Petticrew & Roberts, 2008). Because this is a relatively new topic, I wanted to cast as wide a net as possible and include the grey literature as well as dissertations but focused on studies that were specifically examining the impact of a wide range of egg promotion campaigns (including poultry rearing programs, direct egg provision and nutrition behavior change campaigns). As such, I undertook a googlescholar search for papers that had the terms "egg consumption" AND "nutrition" AND "stunting." Initially, I had excluded the word "stunting" because I am not strictly looking for stunting as an outcome of interest;

however, that search yielded over 9,200 records, many of which were located in the Global North, were in medical journals, and were addressing problems other than malnutrition. After adding "stunting" to narrow the search to studies that were run in environments in which stunting was a problem of interest, the search yielded 512 records. I subsequently reviewed the titles and descriptions and retained only the studies that (1) compared food intake to nutritional outcomes (2) included children, and (3) included a nutrition-related intervention (e.g. I excluded studies which looked at the impacts of cash transfers on nutritional outcomes). This yielded 98 studies (See Figure 3.1). I then conducted a deeper review of these studies and excluded studies that were descriptive (n=25) or correlational (n=33) in nature, and I excluded studies that were redundant with another listing (n=4), were a persuasive piece (n=4), or reviews of other studies (n=6). I excluded one study that was a cost simulation and another that was a master's thesis of a poultry program that had only 40 farmers and no counterfactual. I also added a study that included in one of the reviews of studies but had not come up in my search. These exclusions and one addition resulted in 25 studies, all of which were published since 2010, and 23 of which were published since 2017, highlighting the newness of this line of inquiry.

Figure 3.1: Literature search flow chart



Although there were 25 studies in the final sample, this represents fewer actual egg promotion interventions, as a few interventions spawned multiple reports. For example, a pivotal study in Ecuador was responsible for 5 journal articles, a similar study in Malawi had 4 associated articles, and 2 interventions in Burkina Faso and Ethiopia each produced two associated studies. Nearly all of the studies were run in Sub-Saharan Africa (16) or Latin America (7), though there was one study in Bangladesh and another in Thailand, which was more of a medical trial. The studies were generally quite rigorous methodologically, the majority of which were randomized controlled trials (16) or quasi-

experimental designs (7). Only two studies were solely qualitative in nature and both of them were assessing the mechanisms of behavior change in interventions which also had a randomized controlled trial associated with it.

Direct Provision of Eggs Plus Behavior Change Campaign

The most widely cited study, and arguably the study that sparked the most interest in egg consumption as a solution to malnutrition, was a randomized controlled trial conducted in 2015 in Ecuador (Iannotti et al., 2017a). In this study, children ages 6 to 9 months were randomly assigned to treatment (1 egg per day for 6 months [n = 83]) and control (no intervention [n = 80]) groups. Both arms received social marketing messages to encourage participation in the Lulun Project (lulun meaning "egg" in Kichwa). Egg consumption among young children increased over the course of the 6 months from 40% to 91% in the treatment group. There was also an increase in the control group from 45% to 60%, which indicated a possible impact on egg consumption of the social marketing alone. The study found a reduced prevalence of stunting[8] by 47% and underweight by 74% - a dramatic change rarely found in nutrition interventions. This trial spawned multiple related studies that examined various aspects of the trial across a large range of outcomes. Related analysis of blood plasma in this study population found increases in key nutrients in the treatment group including choline, betaine, methionine, and docosahexaenoic acid (Iannotti et al., 2017b). Choline is necessary for cell membrane integrity and for brain development. This study sheds some light on the biological pathways from egg consumption to reductions in stunting. Another qualitative study,

drawing on key informant interviews, focus group discussions and structured observations, found that eggs were culturally acceptable, locally available and relatively easy to produce, lending support to the idea that scaling of egg consumption is possible (Waters et al., 2018). The authors emphasize the importance of involving all family members in any behavior change campaign and suggest that this behavior change can be achieved through a well-conceived social marketing strategy. Another mixed-methods study examined the behavior change campaign that accompanied the Lulun Project (Gallegos□Riofrío et al., 2018). The behavior change campaign was built on market research focused on culturally-based norms, values, and local expectations; and proceeded through a process of formative research, a situation assessment and testing of various creative concepts. The project logo was an egg wrapped in a traditional cloth in the manner that a mother might wrap a child to her body. The image was intended to represent interconnections and to underscore indigenous worldviews. This evaluation found that the social marketing strategy was pivotal to the RCT's success by encouraging high compliance and low attrition, and the authors ultimately recommended the use of social marketing techniques for scaling up food-based interventions.

Despite these strong results, a follow-up study using the same analysis as the original study found no difference between treatment and control groups for the HAZ (height for age Z score, or the number of standard deviations of the child's height from the median height of the children of his/her age) outcome 2 years after the study ended (Iannotti et al., 2020). There were significant declines in overall HAZ from the endline for the entire study population. However, current egg intake seemed to have a protective effect and was associated with reduced growth faltering. Altogether the results suggest a

more sustained effort might be required in order to maintain gains from any egg promotion campaign.

Some of the same authors from the 2015 Ecuador trial repeated essentially the same study design in another context: Malawi, but with a larger sample size (Stewart et al., 2019). This study was an individual randomized controlled trial in which 660 children aged 6-9 months were equally allocated into an intervention group, which received enough eggs for 1 per day per child, or a control group. Eggs were provided during twice-weekly home visits for 6 months and control households were visited at the same frequency, but without the home egg delivery. The authors found that egg consumption in the treatment group increased from 3.9% at baseline to 84.5% and 70.3% at the 3-mo and 6-mo visits, whereas in the control group, it remained below 8% at all study visits. However, unlike in the Ecuador study, this time the authors found no intervention effect on length-for-age, weight-for-age, or weight-for-length z scores. However, there was a significantly higher head circumference for age z score of 0.18 (95% CI: 0.01, 0.34) in the egg group compared with the control group. There was also significant interaction with maternal education ($p = 0.024$), with an effect on length-for-age z score only among children whose mothers had higher education. The authors surmise that a background diet rich in animal source foods and low prevalence of stunting at baseline may have limited the impact. The study was conducted in a lake region, and two-thirds of respondents reported fish consumption on the previous day. There were also lower rates of stunting at baseline, with only 13% of the children stunted in the treatment group, which the authors think may have impeded the potential of any improvements.

Another study on the same intervention in Malawi looked at how this egg per day intervention affected overall child development for the 6-9 month children enrolled in the trial, using various strategies, including child development tools, eye-tracking tools and techniques to assess memory and attention (Prado et al., 2020). While this trial did not improve linear growth[9] due to the reasons mentioned in the other study, it did have some positive impacts on overall child development in some populations. Specifically, they found the treatment group had less fine motor delays than the control group and that the subgroup of less vulnerable children showed widespread positive effects of the intervention across 7 child development dimensions. Yet another paper from this same study in Malawi examined the impacts on energy consumption and dietary diversity (Lutter et al., 2021). This study found that overall, treatment children were over nine times more likely to consume eggs and that energy intake in the treatment group was 30 kcal per day higher ($p<.0001$). Interestingly, there was also an increase, albeit statistically insignificant ($p=.128$) in energy intake of complementary foods of an equal amount, and no significant displacement of other foods accompanying the increase in egg consumption. The authors also found a 20.5 percentage point difference in the percent of children consuming a minimally diverse diet at endline. Yet another related study dug deeper into the impacts of specific micronutrient consumption and found that the egg treatment group had higher intakes of fat and protein, but lower intakes of carbohydrates (Caswell et al., 2021). The children in the egg intervention group also had lower micronutrient density inadequacy for vitamin A, choline, riboflavin, and vitamin B_5 at endline. So, while the intervention failed to find the dramatic impacts on linear growth

[9] Linear growth is expressed as length-for-age or height-for-age z-score (HAZ) in comparison to normative growth standards.

as was found in the Ecuador study, there is reason to believe that this was due to the low stunting rates at baseline and the high consumption of other animal source protein. The study did detect other positive impacts on child diet, development, and growth.

Testing Two Interventions: Poultry and Poultry + Behavior Change

Several other recent studies that focused on promoting egg consumption through both poultry and behavior change campaigns have found promising results. Two studies evaluated interventions similar in nature to the interventions we are examining with One Acre Fund: a trial arm with a poultry intervention and another with poultry plus a behavior change component. Both were randomized controlled trials, but with relatively small sample sizes. The first was a randomized trial conducted in Burkina Faso (McKune et al., 2020). In this study, the poultry arm included 4 chickens that were given ceremonially as gifts directly to the child and another arm that included poultry plus nutrition training and in-person visits that reinforced messages from a "one child, one egg, each day" egg promotion campaign. The study was run on a rather small sample size of 260 mother-child dyads. Egg consumption at endline was significantly higher in both the poultry + behavior change group ($\beta = 5.64$; $p < .01$) and the poultry-only group ($\beta = 1.74.6$; $P < .01$). Further, wasting was reduced and underweight was slowed among children who received the poultry + behavior change intervention. A mixed-methods follow-up study of this intervention found that treatment women were eager to share what they learned with other women (Moore, 2020). The author also found some evidence that the encouragement from the treatment group had "primed" the control groups to similarly feed eggs to their children. At endline, only 29% of the children in the control group were consuming eggs. However, after the mothers in this group received only 1 training

session and a donation of 2 chickens, egg consumption improved to 83% of children consuming eggs. This suggests that some exposure to the behavior change campaign may have amplified the effects of subsequent training.

Another recent clustered randomized trial conducted in Ethiopia similarly examined the impact of a program that promoted poultry rearing and behavior change (Passarelli et al., 2020). The authors compared a poultry arm in which families received 25 chickens plus training with another arm in which families received the chickens plus nutrition-sensitive training, which included education on a broad range of issues such as home gardening, water and sanitation practices, and gender empowerment, delivered through group meetings. Both interventions showed improvements in HAZ and WAZ at endline (HAZ: 0.28, $p<.05$; WAZ: 0.18, $p<.05$), but these improvements were not statistically significance in the adjusted analysis which added in demographic covariates. In both intervention arms, families earned $11 more from chickens per week than the control group, a significant sum considering it is 50% of monthly food expenditures. The poultry plus behavior change group had better egg consumption and dietary diversity outcomes than the poultry-only arm, and the authors note that there appeared to be a preference for selling eggs in the poultry-only arm and a preference for feeding eggs to children in the poultry plus behavior change arm.

Direct Provision of Eggs

Some studies focused in a more targeted way on promoting egg consumption without introducing a poultry intervention. These interventions generally sought to estimate the extent to which egg consumption might influence child linear growth in more idealized conditions. One of the few studies conducted in Southeast Asia undertook

a randomized crossover design providing 39 children under five in Indonesia who were either stunted or underweight either a vitamin and mineral fortification (to be sprinkled on food) or the fortification plus daily egg supplementation for 3 months (Sudargo et al., 2018). This study found an improvement in the height for age Z score for the fortification plus egg supplement group only ($p<.022$), and the authors concluded that egg supplementation combined with vitamins and mineral fortification could improve linear growth in children. A recent study conducted in Bangladesh provided 12-18 month old children with an egg a day and 150 mL of milk for 3 months and a sachet of micronutrient powder for 2 months. Using a difference-in-difference study design, this study found an improvement in the length-for-age z-score (LAZ) and also found that this effect was even more pronounced for the subgroup of children who were stunted at baseline (Mahfuz et al., 2020). So, the studies which supplied daily eggs to young children directly did find improvements in linear growth.

Two other studies introduced eggs to school-aged children through school feeding programs. The first, a randomized control trial conducted in 2011 in Thailand provided school children (ages 10-12) either 3 or 10 boiled eggs per week for 12 weeks (Mayurasakorn et al., 2011). The authors were interested not in affecting linear growth, given the older ages of the children, but in affecting protein deficiencies, which they assessed through changes in Albumin, PreAlbumin and HDL levels. The authors found that all three outcomes increased significantly due to the intervention ($p<.001$) in both the 3 egg and 1 egg groups, and there was no difference between those two treatment groups. A more recent study was conducted in Uganda in 2017 in which younger children (ages 6-9) received either one or two eggs a day during school for six months (Baum et al.,

2017). This was a difference-in-difference design whereby three schools were followed over the six-month period, one which provided one egg per day, another provided 2 eggs per student per day, and the third provided none. The authors did not discuss issues related to adherence with the egg regime or any limitations to the study having relatively few clusters – only one per treatment. It is possible, but probably unlikely, that another large nutrition intervention or other significant event occurred at one of the three schools which would have affected the authors ability to draw causal conclusions. Their analysis found that children receiving 2 eggs per week had a greater increase in height and weight compared to those children in the 0 eggs and 1 egg groups ($p < 0.05$). Further, participants in both egg groups (1 and 2 per day) had significantly higher ($p < 0.05$) increase in their middle upper arm circumference (MUAC) measurements (MUAC is used to identify acute malnutrition) at six months compared to children in the 0 egg group.

Poultry-Focused Interventions

Many other interventions use poultry as a cost-effective and scalable pathway to improve egg consumption among children. I found five studies that examined the impact of targeted poultry programs (some with a behavior change component) on child nutrition. A phase-in randomized controlled trial, run in 2019 in Guatemala examined the impact of providing local chickens and training on food consumption, expenditures, and child anthropometric indicators (Mullally et al., 2019). This study provided farmers in rural Guatemala 10 female and 2 male chickens after the completion of a 2-month training course, which included support in building a chicken coop and establishing a forage area. The participants also agreed to give chicken offspring to another household

at a later date (28 clusters and 791 households). The authors' study found a 22.5% reduction in stunting ($p<.01$), but only for girls in participating households. The impacts for boys were positive but small and not statistically significant, and the authors surmise this was due to the larger incidence of intestinal disease among boys which can impede linear growth. The pathways for linear growth changes were not clear, as the dietary changes for children were not significant and neither were impacts on household income. However, further analysis of heterogeneous effects found that the poorest children had the largest increase of animal source food consumption but did not have larger impacts on height or weight, possibly due to the higher risks of intestinal disease at the lower income distribution. This finding highlights the complex pathways of egg consumption on nutritional status.

An earlier study, conducted in Bolivia, had a similar program model in which chicken coop building materials and 10 chickens were distributed to treatment farmers who also attended periodic training on nutrition practices (Berti & Cossio, 2017). This study was conducted over a 3-year period, phasing in new communities each year. The study found an increase in self-reported egg consumption based on a dietary 24-hour recall survey among women, children, and men compared to areas that had not yet begun the program, However, these increases in egg consumption did not translate into significant increases in measured intake of overall energy, protein, fat, or percent of dietary energy as fat, calcium, iron, thiamin, riboflavin, or niacin, and the authors did not estimate impacts on linear growth.

In another randomized controlled trial conducted in Ethiopia in 2019, two egg-laying chickens were ceremonially gifted to children, and families were also given

eggshell powder (a dietary supplement) in the treatment group (140 families and 132 in the control group) (Omer et al, 2018 & Omer et al., 2019). This intervention included a behavior change component of monthly counseling and laminated cards which promoted feeding children 1 egg per day. Egg consumption by children was significantly improved, moving from 0.8 to 17 eggs/month ($p < 0.001$), and eggshell powder was widely accepted in the intervention communities. Interestingly, poultry production increased, even excluding the chickens that were gifted to children, indicating some effect of the overall behavior change campaign on chicken production. The authors also found that the egg + eggshell powder intervention increased weight-for-age z-score by 0.24 (95% CI, 0.11-0.37) and reduced underweight (RR, 0.35; 95% CI, 0.16-0.74). Stunting prevalence increased in both groups, but by 28 % less in the treatment group (RR, 0.72; 95% CI, 0.53-0.98) compared with controls. So, while these interventions did not achieve the dramatic reductions in stunting seen in the daily egg deliver program in Ecuador, they did have positive impacts on diet and linear growth through a potentially more scalable model.

Designed to promote the availability and affordability of eggs at the community-level, one study looked at the impact of egg production centers (EPCs) in Zambia (Dumas et al., 2018). In this study, four to five smallholder farmers were recruited in each of the study's 20 project areas to own and operate EPCs. The owner/operators were trained and provided 40 laying hens. This study used a repeated cross□sectional design over 1 year and evaluated program impact on household egg acquisition within those communities, on egg consumption and height□for□age z score (HAZ) among young children (6–36 months). At midline (4 months), households in project areas were

significantly more likely to consume eggs than those in control areas, and this was particularly true for those located within 250 meters of the EPC. There was no measurable impact on children's HAZ, likely possibly due to short follow□up time and the relatively modest "dose" of egg consumption.

Another way to increase the availability of eggs is to reduce the mortality of chickens, who can easily succumb to highly contagious viruses, particularly in large flocks. A 2010 study in Tanzania looked at the impact of vaccinating chickens for Newcastle disease – a virus that can cause 100% mortality in chicken broods and is common in Sub-Saharan Africa (Knueppel et al., 2010). Comparing 3 treatment villages in which vaccines were dispensed, largely free of charge, and 3 matched comparison villages, the authors found that after the first year both mothers and children increased their egg consumption (+1.2 points on the 5 point frequency scale, p=.0003 for mothers and +0.7, p=.003 for children) and that overall food security (as measured by the Household Food Insecurity Access Scale) was improved (p=.020). This effect waned in the second year; however, likely due to some contamination with the comparison areas.

Complex Interventions

I found four studies that looked at the impact of interventions that were complex, either because they spanned multiple countries or had a large basket of services. In these studies, it can be difficult to discern if the impacts seen were attributable to egg consumption, as they were generally part of a larger basket of services. However, at times the authors did attempt to isolate pathways related to egg consumption.

In the first study, conducted in Ghana, participants were provided a large bundle of agriculture and nutrition interventions, which included 40 chickens at point of lay (the

approximate time at which the chickens should start laying eggs), chicken vaccinations, and training on poultry upkeep, nutrition and home gardens (Marquis et al., 2018). There was also community-wide education that included food demonstration, mother-to-mother support groups and community-wide discussions on gender and diversity. This clustered randomized trial provided the full basket of services to 287 households in eight intervention clusters with a control group that contained 213 households. Households were selected for participation based on having children under 12 months, and to be eligible for the trial they had to have successfully constructed chicken coops and fenced a home garden. The odds ratio for the impact of consuming an egg over the previous 24 hours did not differ by treatment group in this experiment, however there was a large and statistically significant impact for children who were consuming eggs at baseline who doubled their likelihood of consuming them at endline. So, the intervention appears to have accelerated the behavior for those who already fed their children eggs. The intervention also improved the likelihood that children were meeting the minimum diet diversity, and children in the treatment group had a higher length-for-age/height-for-age Z score. The authors herald the findings as the first clustered RCT of an integrated agriculture-nutrition intervention to demonstrate a measurable effect on linear growth in young children.

A very large clustered randomized trial with 4 treatment arms is currently being conducted in Ethiopia (Alderman et al., 2020). The study design is complex and includes a low intensity and high intensity livelihood program that includes training on financial literacy, agriculture and livestock value chain development, and targeted poultry or cash interventions, among other components. It also includes a low and high intensity

nutrition program that consists of nutrition behavior change communication WASH activities, and group therapy (for the high intensity arm), among other provisions. The study also intends to look at a broad range of outcomes including income, savings, food security, child nutritional status, and women's empowerment. There is, therefore, not a unitary focus on poultry or even on child nutrition, though these will be captured. The midline report, conducted 15 months after the interventions were rolled out, found a boost in income from poultry but no positive impacts on stunting comparing any treatment arm to the control arm. Given the multiple permutations of the intervention, the authors were able to conduct some secondary analyses looking at the impact of a poultry transfer compared to a cash transfer of similar value on egg consumption. They found that children in the poultry group more than doubled their probability of consuming eggs in the previous day compared to the control group, a result that was statistically significant. However, the children in the cash transfer group did not have a statistically significant increase in their egg consumption, providing support that direct provision of poultry helps reduce barriers to egg consumption.

Another study in Tanzania provided a "basket" of nutrition interventions as part of a program called Rural Initiatives for Participatory Agricultural Transformation (RIPAT) (Larsen & Lilleor, 2017). The intervention included training on agricultural practices, improved varieties of crops, opportunities to practice techniques on demonstration plots, and improved poultry breeds, among other agricultural supports, and the researchers measured linear growth of children as a key outcome of the project. The data were collected after the project started, so the researchers were not able to measure changes over time from baseline. However, they were able to assess whether children

who were conceived after project phase-in were taller for their age than their older peers who were conceived earlier, relative to a similar cohort difference between younger and older children from comparison households. They found that an increase in height-for-age of 0.9 standard deviations and that stunting rates decreased by 17.6 percentage points. While the causal mechanisms were not experimentally tested, the authors surmised that this result was driven in large part by increases in livestock holdings and dietary changes. Specifically, the treatment group was much more likely to have improved chickens, and egg consumption was 50% higher among the treatment group.

The most expansive study was conducted in four African countries (Burkina Faso, Tanzania, Senegal, and Cote d'Ivoire) and provided a general nutrition package that encouraged families to adopt micronutrient-rich crops to feed their young children and included a social behavior change campaign with in-person facilitated discussions (Nordhagen & Klemm, 2018). All projects included a poultry component, but this varied across countries, with some receiving chickens at the village level and others at the individual level, and the interventions were adapted to local conditions and needs. In Burkina Faso, families received 2 local hens, but had to pay some of the cost, and the communities were instructed on how to build poultry facilities and provided with 10 hens and 1 rooster. In Cote d'Ivoire women's groups were provided with community hen houses and hens, as well as training. In Tanzania and Senegal, the treatment did not include the community-level intervention. All countries included a social behavior change component which encouraged egg consumption of children 6-23 months. The effect on egg consumption was rather modest and remained low in four countries at 1-3 eggs consumed per household per week, which was far less than the number of eggs

produced. However, the more intensive intervention in a more urban location in Senegal induced much higher egg consumption, achieving its goal of 1 egg per week during some of the data collection periods. In every country, about half of the eggs eaten in the household were fed to the youngest child, something the campaign was actively encouraging. The authors suggest that the SBCC campaign seemed to influence egg consumptions in these communities in which egg consumption was previously quite low. Knowledge of the benefits of eggs dramatically increased over the project duration and those mothers who actively participated in the SBCC in the prior month reported much higher egg consumption.

Themes and Trends

In this systematic review of the literature, I identify several key trends. First, there is fairly strong support for the overall efficacy of egg consumption in improving childhood linear growth and/or nutritional status. However, there is some evidence that these programs could be more effective if conducted in areas with high rates of stunting and with lower availability of animal source protein from other sources, and there is concern that these results could dissipate if the treatments are not sustained. Secondly, the studies reviewed here show promising evidence that providing poultry, along with training and some behavior change support can increase the self-reported consumption of eggs among children. However, none of these studies attempted to control for any kind of self-reporting bias, so we might be worried that self-reports were inflated. This is particularly problematic when the treatment included a behavior change campaign which would exacerbate this bias for treatment relative to control groups. Third, many of the studies noted that behavior change campaigns were a key component of their success,

which was generally supported by qualitative evidence. However, none of the studies delineated in detail the specific behavior change levers or pathways or what behavioral science principles were at play. So, it is difficult to fully understand that behavior change blockers and motivators. Fourth, I did not find any study which employed mass marketing multi-media campaigns which covered a large population and has greater potential for scale. Finally, the egg and poultry studies reviewed here were generally conducted on a small sample size (min=121; max = 829; median=417) and/or included a fairly intensive and expensive intervention, which could be more challenging to scale.

This systematic review of the literature provides fairly compelling evidence that programs that promote egg consumption can improve child nutritional status. Multiple studies show an improvement in linear growth, reduction in malnutrition or reduction in growth faltering as a result of egg or poultry interventions (Iannotti et al., 2017; McKune et al., 2020; Omer et al., 2019; Sudargo et al., 2018; Baum 2017; Mullaly et al., 2019; Passarelli et al., 2020; Baum et al., 2017) or as a result of a more complex program which includes poultry and egg consumption promotion as a key component (Mahfuz et al., 2020; Marquis et al., 2018; Larsen & Lilleor, 2017). However, not all studies found these same impacts, though for some the lack of detectable impact was potentially due to the short study duration of follow up, low overall egg consumption among children, or low rates of stunting in the study area (e.g. Dumas et al., 2018; Alderman et al., 2020; Berti & Cossio, 2017) or other important contextual factors (Stewart et al., 2019). For example, the study in Malawi, modeled after the pivotal Ecuador study, failed to find any improvements in linear growth. However, the authors reason that the lack of an impact was likely due to relatively low baseline stunting rates and the high consumption of other

(fish) animal source proteins. This context highlights the importance of locating egg promotion interventions in communities with relatively high stunting rates and low consumption of similarly beneficial animal source proteins in order to achieve a measureable impact on child nutrition. Rural Rwanda has much higher stunting rates than the population studied in Malawi (36% vs. 13%). Rwandan children also have very low consumption of other animal source proteins.

Some studies that did not show a reduction in stunting prevalence or malnutrition, did find improvements in other child development indicators and nutrient quality (Lutter et al., 2020; Caswell et al., 2021; Prado et al., 2020; Mayurasakorn et al., 2011). Given its highly deleterious effects on lifetime health and well-being, reduction in stunting should remain a primary goal of those interested in reducing global poverty and inequality. However, the improvements in dietary diversity, fat, protein, choline and reductions in fine motor delays found in these studies, also have material health and development benefits from undernourished children.

Only one study (Iannotti et al., 2020) followed up with participants years later to see if the improvements from the intervention were sustained over time. Concerningly, these authors found that the HAZ had declined for both groups since the end of the original 6-month daily egg intervention, and differences in HAZ did not persist between the treatment and control groups. However, current egg consumption was associated with reduced growth faltering. These findings highlight the importance of a sustained intervention, even beyond the "1000 days" (gestation plus the first two years) which is often emphasized as the crucial window for affecting stunting.

One cost-effective way to ensure a more sustained supply of eggs is through poultry adoption programs. The studies of such programs reviewed here demonstrated fairly convincingly that providing poultry, along with training and some behavior change support can significantly increase the consumption of eggs among children (McKune et al., 2020; Mullaly et al., 2019; Berti & Cossio, 2017; Dumas et al., 2018; Knueppel et al., 2010; Alderman et al., 2020; Larsen & Lilleor, 2017; Omer et al., 2019; Nordhagen & Klemm, 2018.) Many of these interventions provided poultry for free as well as training and/or other supports, like chicken coop materials, which can be expensive programs to run at scale. However, two studies explored more cost-effective models – vaccination campaigns and community level egg production centers, which also found promising results in terms of egg consumption. None of these studies addressed the methodological limitation that egg consumption was always self-reported, and there might be considerable social pressure for the participants in the treatment group, who had been instructed to feed eggs to their children, to report higher egg consumption. Some of the poultry studies (4 of 9) collected physical or bio-marker evidence of nutritional status, which supported the increase of egg consumption, so the challenges around self-reporting were less material. However, not all studies collected anthropometric or biomarker outcomes, and instead relied solely on dietary recall data to assess egg consumption, with no discussion of potential reporting bias. In addition, if self-reported increase in egg consumption is not reliable, this makes analyzing the pathways between egg consumption and other health outcomes challenging even for the studies which did collect physical evidence of nutritional status.

Another recurring theme in the studies reviewed is the importance of behavior change and social marketing to encourage caregivers to increase egg feeding to their children. Feeding preferences are notoriously "sticky" and difficult to change, so many studies included a component that encouraged caregivers to prioritize feeding eggs to young children rather than selling them at the market. Multiple studies indeed found that social marketing improved egg consumption and some other related outcomes (McKune, et al., 2020; Passarelli et al., 2020; Nordhagen & Klemm, 2018; Moore, 2020; Nordhagen & Klemm, 2018). One of the qualitative studies of the Lulan project in Ecuador also concluded that the social marketing was a key component to induce behavior change. In fact, in the original study, children in the control group, which had also received social marketing, also increased egg consumption over the 6-month study period. However, none of the studies reviewed here dedicated much time to illuminating the pathways of behavior change or explicating the behavioral science principles used in behavior change or social marketing campaigns. For programs with a behavior change campaign, it was not always clear why certain messages were preferred over others, and on what theory they were based. It is thus difficult to understand which tactics have been most successful and why.

None of the studies reviewed had a behavior change campaign that used mass media, which has the potential to scale impact a lot farther and more cost effective. There is one study, currently underway, in Kaduna state Nigeria, which will assess the effectiveness of a large scale campaign to promote egg consumption (LaRose et al., 2020). This is a large multi-pronged behavior change campaign focusing on encouraging egg consumption among young children through radio, television, posters at market

centers and community-level activities. The impact evaluation will be a mixed methods quasi-experimental approach comparing Kaduna state to similar bordering areas. However, the authors note that eggs are widely available and affordable in that context, and so the barriers in the Nigerian context are different from what rural families in Rwanda, or other low-income rural areas in which eggs are rare and expensive, face.

Overall, the poultry and egg focused interventions had rather small sample sizes (min=121; max = 829; median=417) and were generally quite intensive interventions. Therefore, these studies do not provide a ready recipe for scaling interventions due to the operational and budgetary challenges of bringing intensive interventions to scale. In addition, I was unable to find any studies that provided cost-benefit or cost-effectiveness assessments of the interventions. Reductions in stunting can lead to large lifetime benefits in reduced morbidity and mortality, and increased lifetime earnings. It is likely that even expensive interventions would pass a cost-benefit assessment. In addition, the largest studies I found were generally of complex interventions. In order to maximize the likelihood of impact of a sizeable investment, the program funders likely reasoned that a multi-pronged approach was warranted. However, this makes it difficult to isolate the impact of the various components to determine which are the most effective.

This study appears to be the first to attempt to assess two scalable approaches to encourage egg consumption, i.e. mass social media marketing and a poultry on credit scheme, and to include a cost-effectiveness comparison of the two components. In addition, in no other study was I able to find a discussion of the limitations of self-reporting biases or attempts to correct from them, when estimating egg consumption among children, was the primary outcome of interest.

In the next chapter I describe the formative research which was undertaking in order to design a behavior change campaign which intended to address the motivational barriers of caregivers to feed their children eggs.

Figure 3.2: Summary of literature

Study	Location	Intervention	Methods	Outcome on children	Other outcomes
Mahfuz et al., 2020	Bangladesh	A community-based intervention in which 12–18-mo-old children with length-for-age z score (LAZ) <1 were supplemented daily with an egg and 150 mL of milk for 90 feeding days, and 1 sachet of multiple micronutrient powder was provided daily for 60 feeding days	Difference in difference analysis (n=472+174)	change in LAZ in the intervention group of +0.23 (95% CI: 0.18, 0.29; P < 0.05). In a subgroup analysis, the changes were +0.27 (95% CI: 0.18, 0.35; P < 0.05) in stunted (LAZ <2) children and +0.19 (95% CI: 0.12, 0.27; P < 0.05) in children at risk of stunting (LAZ −1 to −2). No allergic reactions or other adverse events related to milk and egg consumption were observed.	
Berti & Cossio, 2017	Bolivia	Participating households received three sheets of corrugated zinc to serve as the roof of the chicken coop, constructed by the participants out of zinc and local materials. After the coop was constructed they received ten chickens, three to five weeks of age, vaccinated against Newcastle disease, as a starter flock. Eight of the 10 were "Pirocas", a breed of Peruvian origin which are efficient egg producers. Two of the 10 were a locally adapted breed that are used as brooders.	Non-randomized phase-in trial. (n= 22 households in phase 1, n=33 in phase 2, n= 66 in phase 3)	Egg consumption increased to approximately one-half egg/person/day: in children from 7 to 33 g/day, in women from 6 to 33 g/day, and in men from 6 to 39 g/day. Despite the increased intake in eggs, intake of most nutrients did not change.	

Study	Location	Intervention	Methods	Outcome on children	Other outcomes
McKune et al., 2020	Burkina Faso	Each child (4-17 months) in the full intervention arm received 4 chickens (3 gifted by comm leader directly to the child), and mothers received the 10-month behavior change package. Participants in the partial intervention arm received only the behavior change package (monthly integrated nutrition and agriculture trainings; individual counseling of mothers during monthly monitoring sessions; distribution of a culturally appropriate, picture-based flipbook that reinforced key messages; development and fostered use of a project jingle (ie, "One child, one egg, each day!"); and engagement of strategically targeted community leaders as champions of the project.	3 arm cluster RCT (n= 250 mom-child dyads.)	The full (b = 4.3; P = 6.6 3 10212) and the partial (b = 1.0; P = .02) interventions significantly increased egg consumption. The full intervention significantly decreased wasting (b = .58; P = .03) and underweight (b = .47; P = .02) and yielded a greater in crease in egg consumption.	
Moore, 2020	Burkina Faso	Same as above	clustered randomized trial. (n=250 mom-child dyads) Plus a follow up survey + qualitative methods on women's empowerment	At endline in the control group only 29% of the children were consuming eggs. After the mothers in the control group received 1 training session and a donation of 2 chickens, egg consumption improved to 83% consuming eggs. Author points to importance of "priming" through the surveying and some exposure to the treatment which supported this result.	Significant positive relationship between women's decision making score and children's egg consumption. The project also improved women's decision-making power within the household.

Study	Location	Intervention	Methods	Outcome on children	Other outcomes
Nordhagen & Klemm, 2018	Burkina Faso, Tanzania, Senegal, and Cote d'Ivoire	Across all four countries, participants were encouraged to adopt home gardens to grow micronutrient-rich crops to feed their families (particularly young children). Nutrition SBCC was centered on a revised Essential Nutrition Actions and Essential Hygiene Actions (ENA/EHA) toolkit (Guyon, Quinn, Nielsen, & Stone-Jimenez, 2015), with close attention to building community agents' skills for facilitating interactive discussions and counselling. Messages were delivered by trained volunteers through once- or twice-monthly group discussions as well as home visits, radio programs, and community event. The interventions included a poultry component which varied across country, some had village-level plus individual level poultry interventions others just had individual interventions.	Cross sectional monitoring surveys across consecutive survey rounds. (Burkina Faso, n=2400; Cote d'Ivoire, n=2816; Senegal, n=1300; Tanzania, n=1232)	Egg consumption remained low in the three rural settings, with two to six eggs reported consumed by the household in the prior fortnight, far less than the number produced. The intensive system used in Senegal saw much higher levels of consumption, reaching over an egg a day (for the household) at its peak. In each country, about half of the eggs eaten in the household were reportedly fed to the youngest child. Mothers who actively participated in the SBCC in the prior month reported much higher egg consumption	
Iannotti et al., 2017	Ecaudor	Children 6-9 months old were given 1 egg per day. Both treatment and control arms received social marketing messages to encourage participation in the project and consumption of eggs.	Randomized controlled trial (n=163)	Egg consumption among young children over the course of 6 months increased 128% in the intervention group (from 40% to 91%) compared with only 33% in the control group (45% to 60%) Found a reduced prevalence of stunting by 47% prevalence ratio [PR], 0.53; 95% CI, 0.37–0.77) and underweight by 74% (PR, 0.26; 95% CI, 0.10–0.70).	

Study	Location	Intervention	Methods	Outcome on children	Other outcomes
Waters, et al., 2018	Ecuador	same as above	same as above + A qualitative component was conducted to understand local perceptions, knowledge, and practices. this consisted of key informant interviews, focus group discussions (FGDs), and structured observations in order to understand perceptions, knowledge, and practices		Found eggs are an available and culturally acceptable food source although they are not always a part of the diet; and perceptions and practices related to household consumption and the introduction of eggs into the diet of infants are shaped by local knowledge and practices, which are shaped by biomedical information and advice provided by public health professionals.
Iannotti et al., 2017	Ecuador	same as above	Randomized controlled trial (n=163)	The egg intervention increased plasma concentrations compared with control by the following effect sizes: choline, 0.35 (95% CI: 0.12, 0.57); betaine, 0.29 (95% CI: 0.01, 0.58); methionine, 0.31 (95% CI: 0.03, 0.60); docosahexaenoic acid, 0.43 (95% CI: 0.13, 0.73); DMA, 0.37 (95% CI: 0.37, 0.69); and TMAO, 0.33 (95% CI: 0.08, 0.58). No significant group differences were found for vitamin B-12, retinol, linoleic acid (LA), α-linolenic acid (ALA), or ratios of betaine to choline and LA to ALA.	

Study	Location	Intervention	Methods	Outcome on children	Other outcomes
Gallegos Riofrío, et al., 2018	Ecuador	Same as above, but this study focused on the social marketing campaign. To develop the social marketing campaign, the authors conducted (a) market research focused on culturally based norms, values, and local expectations; (b) a situational assessment based on the four Ps of social marketing (people, product, place, and price); and (c) fostered a creative process to develop the project's brand and communication plan. The strategy combined a communication plan, brand, and activities that were implemented in four campaigns: outreach, recruitment, promotion, and closing.	The evaluation of the social marketing strategy was based on fieldwork monitoring reports, RCT data, individual interviews, focus group discussions, and documentation provided by the MPH		Found that the social marketing strategy was instrumental in promoting the RCT's objectives and responding to unforeseen events and community concerns regarding the RCT. The strategy resulted in high compliance, low attrition, and even infant feeding policy change,
Iannotti et al., 2020	Ecuador	Same as above.	Follow up study to the 2017 RCT to test whether the growth effect remained in the egg intervention group compared with the control group after approximately 2 years. Statistical analyses followed the same analytical plan as initial study. (n=135)	Found no difference between egg and control groups for the HAZ outcome and other anthropometric outcomes, and significant declines in HAZ from endline of the initial study. Dietary egg intake, however, was associated with reduced growth faltering in HAZ from Lulun Project endline to this follow-up independent of group assignment and through mediation.	
Passarelli et al., 2020	Ethiopia	There were 2 interventions provided to households with children 0-36 months: (1) genetically improved foraging chickens + training: households received 25 vaccinated chicks + training (2) above + nutrition sensitive behavior change communication, which included home gardening, provision of fruit and vegetable seeds and training emphasizing nutrition and WASH best practices. Both	Clustered RCT (n=829)	Both interventions showed improvements in HAZ and WAZ at endline (HAZ: 0.28, $p<.05$; WAZ: 0.18, $p<.05$), but these improvements were not significance in the adjusted analysis which added in demographic covariates. The poultry + behavior change group had better egg consumption and dietary diversity outcomes than the poultry-only arm.	In both intervention arms, families earned $11 more from chickens per week than the control group,

Study	Location	Intervention	Methods	Outcome on children	Other outcomes
		took place over a 14 month period.			
Omer et al., 2018	Ethiopia	Enrolled children, 6-12 months received a gift of two egg laying chickens; families received education on poultry production and training on the importance of consumption of egg for young children. Egg shell protein (500 mg Ca) was given to children at ≥12 mo. The Control group received nutrition education. Duration of trial was 6 months.	Cluster RCT (n=272)	Children in the intervention group improved their egg consumption from 0.8 to 17 eggs/month ($p < 0.001$), but not in the control group. ESP achieved 17 days/month ($p < 0.001$).	Poultry production increased in the Intervention communities even when child-owned chickens were excluded from analysis (from 138 to 251 chickens)
Omer et al., 2019	Ethiopia	Same as above	Same as above	Egg+ESP intervention increased weight-for-age z-score by 0.24 (95% CI, 0.11-0.37) and reduced underweight (RR, 0.35; 95% CI, 0.16-0.74). Stunting prevalence increased in both groups, but by 28 % less in the treatment group (RR, 0.72; 95% CI, 0.53-0.98) compared with control.	

Study	Location	Intervention	Methods	Outcome on children	Other outcomes
Alderman et al., 2019	Ethiopia	4 interventions L: SPIR livelihood activities, financial literacy training, agriculture and livestock value chain development, home gardening and forage production Intervention L*: SPIR livelihoods activities plus (i) social analysis and action (SAA) to improve women's access to markets, (ii) aspirations promotion activities in randomly selected kebeles (subdistricts), and (iii) targeted poultry or cash livelihood transfers Intervention N: Nutrition Behavior Change Communication (BCC); WASH activities Intervention N*: N + additional community engagement and more intensive group work (e.g. male engagement and women screened for depression) First 2 received poultry package (16 Sassos, feed, material for a coop, + training.)	clustered RCT; sample (n= 4082)	Midline report (endline not yet available) found boosts in income all treatment groups, but not yet any stunting differences. Children in the arms which included the poultry program doubled their probability of consuming eggs the previous day.	
Marquis et al., 2018	Ghana	12-month intervention (inputs and training for poultry farming and home gardening, and nutrition and health education, including food demonstration and discussions on gender and diversity)	Clustered randomized trial. (16 total clusters, 287+213 households)	Compared with children in the control group, children in the intervention group were more likely to meet minimum diet diversity (adjusted odds ratio = 1.65, 95% CI [1.02, 2.69]) had a higher LAZ/HAZ (β = 0.22, 95% CI [0.09, 0.34]) and had higher WAZ (β = 0.15, 95% CI [0.00, 0.30]).	
Mullally et al., 2019	Guatemala	Participant families were gifted 10 females and two males of the "naked-neck" (hearty foragers) variety as well as commercial feed and forage plant for use once the feed supply was exhausted. They received these chickens after a 2 month training course.	RCT phase in design (791 households and 28 clusters)	The program reduced stunting by 23 percentage points among girls, while also improving other height and weight outcomes. Children in the poorest households experienced the largest increases in animal source food consumption, but that these impacts did not translate into larger effects on height or weight.	

Study	Location	Intervention	Methods	Outcome on children	Other outcomes
Stewart et al., 2019	Malawi	Eggs (enough for 1 per day) were provided during twice-weekly home visits for 6 months. Control households were visited at the same frequency but not provided with eggs.	Individually randomized controlled trial (n=660)	Egg consumption increased from 3.9% at baseline to 84.5% and 70.3% at the 3-mo and 6-mo visits, whereas in the control group, it remained below 8% at all study visits. There was no intervention effect on length-for-age, weight-for-age, or weight-for-length z scores. There was a significantly higher head circumference for age z score of 0.18 (95% CI: 0.01, 0.34) in the egg group compared with the control group. There was a significant interaction with maternal education (P = 0.024), with an effect on length-for-age z score only among children whose mothers had higher education.	The authors surmise that a background diet rich in animal source foods and low prevalence of stunting at baseline may have limited the potential impact. Study done near a lake and 2/3 reported fish consumption on the previous day. There were also lower rates of stunting at baseline with only 13% of the children stunted in the treatment group which the authors thing may have impeded the potential of any improvements
Prado et al., 2020	Malawi	same as above	Same as above. Additional child developmental assessments were administered.	At endline, intervention and control groups did not significantly differ in any developmental score, with the exception that a smaller percentage of children were delayed in fine motor development in the intervention group (10.6%) compared with the control group (16.5%; prevalence ratio: 0.59, 95% CI: 0.38–0.91). Also, children who were less vulnerable, for example, those with higher household wealth and maternal education, showed positive effects of the intervention.	

Study	Location	Intervention	Methods	Outcome on children	Other outcomes
Lutter et al., 2021	Malawi	same as above	same as above	Compared with controls, children in the egg group were over nine times more likely to consume eggs at midline and endline. At midline and endline, more than 80% of children in the egg group consumed a minimally diverse diet compared with 53% at midline and 60% at endline in the control group.	
Caswell et al., 2021	Malawi	same as above	same as above	The egg intervention resulted in higher intakes of fat and protein and lower intakes of carbohydrates. The egg group had lower prevalence of inadequacy for selenium, vitamin A, riboflavin, vitamin B5, vitamin B12 and choline. Micronutrient density inadequacy was lower in the egg group for vitamin A and choline at midline and endline, riboflavin at midline and vitamin B5 at endline. Inadequacy of nutrient intakes or density remained highly prevalent in both groups for multiple micronutrients.	
Knueppel et al., 2010	Tanzania	Vaccination for Newcastle disease. Newcastle disease is capable of causing 100% mortality in flocks.	Comparison between 3 control villages and 3 treatment villages. Random selection of participants. (N= 237+261)	Children increased their egg consumption (+1.2 points on the 5 point frequency scale, p=.0003 for mothers and +0.7, p=.003 for children) and that overall food security (as measured by the Household Food Insecurity Access Scale) was improved (p=.020). This effect waned in the second year	
Larsen & Lilleør, 2017	Tanzania	Voluntary participants received a basket of services (each village could decide what they want), which included improved varieties of banana with new cultivation techniques, conservation agriculture and crop diversification, improved animal husbandry, fruit and multipurpose trees, soil and water conservation,	Difference-in-difference (n=506+395)	Stat sig increase in egg consumption (but at the hh level) Young children in RIPAT households were 0.88 SD taller than their peers in comparison households, controlling for any pre-project differences among the older children Found a reduction in the prevalence of stunting of 17.6 percentage points, significant at the ten percent level.	

Study	Location	Intervention	Methods	Outcome on children	Other outcomes
		post-harvesting technologies, and encouragement to participate in savings groups. (25% had improved poultry breeds)			
Mayurasakorn et a., 2011	Thailand	Provided school children (ages 10-12) 3 or 10 boiled eggs per week for 12 weeks.	RCT (n=417)	Albumin, PreAlbumin and HDL levels have demonstrated significantly increasing levels ($p < 0.001$). Authors conclude hat An addition of at least 3 eggs/wk supplements can effectively correct the problem of protein malnutrition among primary school students at risk as shown by biochemical indices, and it benefits the blood cholesterol level as well.	
Baum et al., 2017	Uganda	Children (ages 6–9) in 3 schools received either one egg or 2 eggs a day for 6 months	Difference in difference. (n=241)	The children receiving 2 eggs per week had a greater increase in height and weight compared to the 0 eggs and 1 egg groups ($P < 0.05$). In addition, participants receiving 1 egg and 2 eggs had a significantly higher ($P < 0.05$) increase in MUAC at six months compared to 0 eggs.	
Dumas, 2017	Zambia	Village level egg production centers were stocked with 40 hens, 4-5 farmers trained in food safety and business to run the center	repeated cross sectional design, with comparison area (n=805)	Egg production centers increased acquisition and consumption of eggs by households, women and young children in participating communities No effect on HAZ or dietary diversity for women or children.	

Chapter 4: Formative Research and Intervention Design

Successfully affecting behavior change is commonly understood to be very challenging. So much so that evaluation theorist Peter Rossi put forth the Brass Law of Evaluation, which states that "The more social programs are designed to change individuals, the more likely the net impact of the program will be zero." (Rossi, 1987, pg. 5) While this pessimistic view of social change was partly tongue-in-cheek, it serves to underscore the truly daunting nature of behavior change. Designing an effective behavior change strategy requires a deep understanding of the barriers that block that behavior and the motivators that might encourage it. In this chapter, I first present the Capabilities, Opportunities and Motivation (COM-B) framework as a guiding model for understanding behavior change. I then summarize the formative research which was conducted in order to inform the intervention, and analyze that work according to the COM-B framework. I then describe the intervention arms, with a particular focus on the behavior change strategy, including the themes, the dissemination vehicles and the associated behavioral science theoretical underpinnings of each strategy.

Behavior Change Framework: COM-B Model

At the most fundamental level, behavior change can be understood through exchange theory, which was first introduced into the discipline of social psychology by George Homans (Cook et al., 2013). This theory views behavior decisions as the result of a mental calculation between the social costs and the ensuing benefits, both of which can be material or psychological. A behavior is most likely to happen if the benefits outweigh the costs. This theory has a certain elegant, if obvious, logic to it, but does not

help us necessarily understand the complicated array of a person's costs and benefits associated with a behavior or decision. When designing a program aimed at behavior change, the first and foundational task is to understand the social, material, and psychological costs and benefits of adopting that behavior.

There is a dizzying array of frameworks on which program designers can rely to help organize their thinking and conduct analysis. For example, "Intervention mapping" asks program designers to assess (1) knowledge, (2) awareness, (3) risk perception, (4) habit (5) attitude, (6) social influence, (7) skills/self-efficacy, (8) environment, and (9) social norms (Bartholomew et al., 2011). The model developed by Defra (the UK Department for Environment, Food and Rural Affairs) to increase pro-environmental behavior, with admirable alliteration, asks program designers to think through how to (1) enable, (2) encourage, (3) engage and (4) exemplify (lead by example) to achieve effective behavior change (Darton, 2008). A systematic search, by Michie and co-authors, found and evaluated fully 19 behavior change frameworks; however, the authors noted that despite the surfeit of theoretical models, many programs and interventions are designed without any reference to theoretical frameworks or rely on frameworks, which are incomplete (Michie et al., 2011).

For this study I chose the COM-B framework, as it is the most conceptually parsimonious and most frequently used approach in the public health context. The COM-B framework was developed by Susan Michie and co-authors after a systematic review of available frameworks, that sought to identify central factors that were comprehensive, coherent and useful (i.e. had a clear link to an overarching model of behavior) (Michie et al., 2011). They drew from a consensus meeting of behavioral scientists that identified

that skills, intention and having no environmental binding constraints were the three prerequisites for volitional behavior. This was confirmed by a review of criminal law in which a prosecutor must show capability, opportunity, and motive. Their analysis resulted in three core concepts of capability (a person's psychological and physical ability), opportunity (external factors that make the behavior possible), and motivation (person's both conscious and unconscious belief). (see Figure 4.1.) These three constructs encompass factors that are internal (such as psychological or physical states) as well as external (such as what is readily available or valued in the environment). For example, capability can be both physical (you are physically able to raise chickens) and psychological (you believe in your ability to do so). The model builds out from this conceptual center to a layer of intervention functions (e.g. training and education) and policy categories (e.g. regulation and service provision). See Figure 4.2.

Figure 4.1: COM-B Model

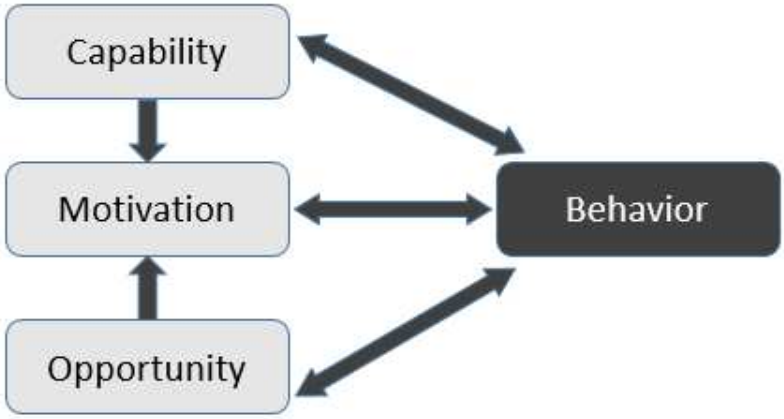
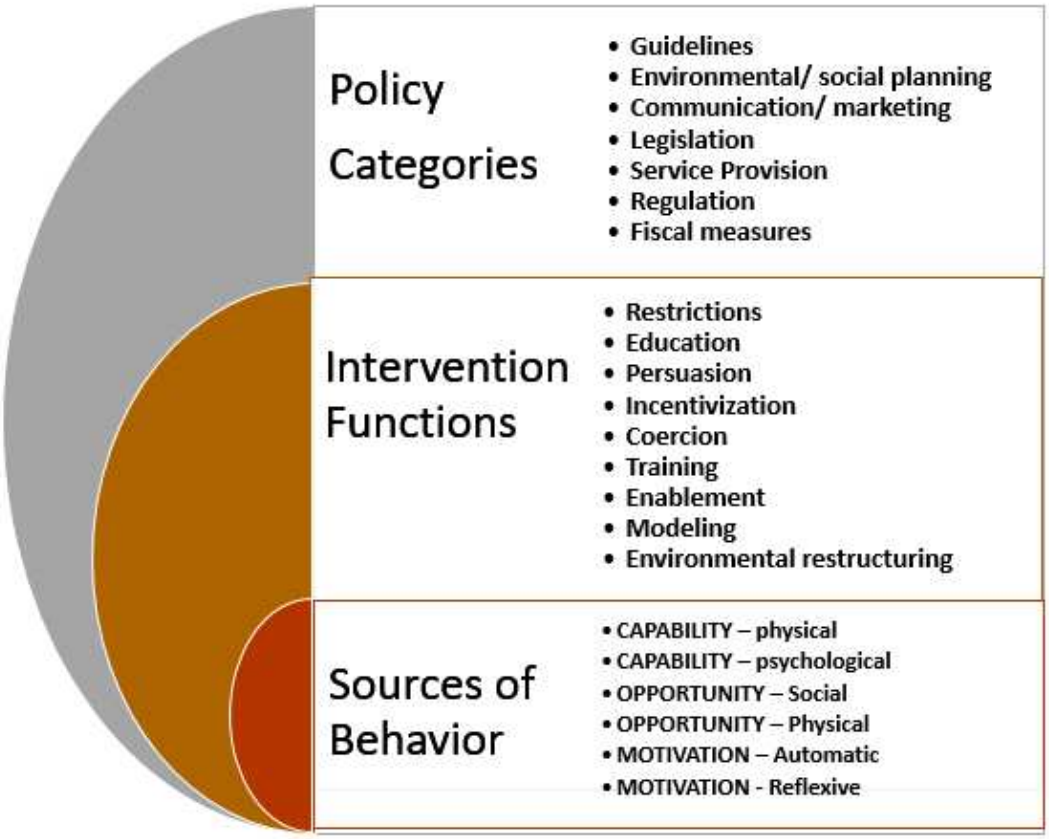


Figure 4.2: COM-B Wheel of behaviors, intervention functions and policy categories



The COM-B framework has been criticized as being too reductionist and not easily falsifiable (Ogden, 2016). However, those criticisms likely apply to many other behavior change models, and COM-B's relatively simplicity and solid empirical and theoretical grounding make it a strong starting place for understanding typical behavior in novel contexts.

Formative Research

The first step in designing a behavior change intervention is to truly understand the context, and what might be the barriers to capabilities, opportunity and motivation.

As such, we[10] initially undertook focus group discussions with groups of 8-10 farmers to discuss their views about feeding their young children. However, the responses we initially received contradicted the empirical data on egg consumption and what the facilitators knew to be the state of affairs. Specifically, in focus groups many more interviewees reported feeding eggs to their children than was likely the case. The local facilitators hypothesized that interviewees were not speaking freely and truthfully due to group social pressure, so we pivoted to conducting structured one-on-one interviews with caregivers of children under 3. We first administered a phone survey to identify farmers who were feeding eggs to their children at least once a week (egg feeders) and those who were not regularly feeding eggs to children (non-egg feeders). Interviewees were quite willing to report that they were not feeding their children eggs over the phone, so we did not have the same challenges of social pressure seen in the initial focus groups. Trained Rwandan facilitators from rural areas subsequently administered structured in person interviews to 16 egg feeders and 16 non-egg feeders in January and February of 2021.

As seen in Table 4.1 below, we obtained a roughly equal mix of female and male interviewees who were caring for an average of 4.4 children. The median interviewee age was 40, as the interviewee pool include a number of grandparents who were primary caregivers of their grandchildren. In addition, the average age of One Acre Fund program participants is Rwanda is over 40[11], so the interviewees potentially skew older than typical rural caregivers of young children. We analyzed the data in Quirkos and Excel and identified themes associated with capabilities, opportunity and motivation.

[10] I worked with a One Acre Fund qualitative research team as well as with the One Acre Fund nutrition lead to conduct the formative research and design the behavior change campaign. Therefore, I use "we" in this chapter.
[11] According to One Acre Fund internal survey data.

Table 4.1: In-depth interview statistics

	Sample size	Average number of children	Median age	Percent female	No of eggs fed per week
Egg feeders	16	4.7	40	50%	2.8
Non-egg feeders	16	4.1	40	60%	0
TOTAL	32	4.4	40	55%	

Capability (knowledge and affordability)

The data gathered during these interviews demonstrate that knowledge of nutritional benefits is not a large barrier to egg consumption, as most interviewees interviewed were able to outline some health benefits of eggs. In fact, the most common reason that egg feeders cited for feeding eggs to children was related to health rather than children's preference, convenience or habit. The most common themes related to egg feeding were providing nutrients, promoting growth, adding protein, and protecting from disease. Interviewees not only had a clear understanding of the nutritional benefits of eggs, but they appeared to take pride in their nutrition knowledge and ability to provide this resource for their children (see **Error! Reference source not found.**).

Table 4.2: Interviewee statements about their knowledge of egg feeding benefits

"Eggs help in the development of the child, to help him get the nutrients he needs." (EF*, male)"
"The under 5 Years old child is not living with his mother to benefit from the important nutrients from breastfeeding so far I prefer to seek for eggs to him for better grow up." (EF, female)
"I know that eggs are good for children and that they are rich in nutrients which are good for their growth" (EF, female)
"It is important that children eat eggs when they are still young to develop strong bones." (EF, female)
"Yes, one day I made conversation with someone and we talked about eggs. He told me that eggs increase the bone marrow. There was again someone injured his leg and doctor asked him to eat eggs. That is why I take care for feeding my children eggs." (EF, male)
It is important that children eat eggs when they are still young to develop strong bones.(EF, female)
"To avoid them (children) to face with the late growing [stunting] and I need them (eggs) to grow better in physically and mentally" (NEF, male)
* EF= Egg feeder; NEF = Non-egg feeder

Some interviewees also described eggs as a healthy but cheaper substitute for relatively expensive foods like meat, fish, or store-bought porridge (See Table 4.3).

Table 4.3: Interviewees' statements about eggs as a substitute for other foods

"In the village we have no Cerelac (instant fortified cereal), no porridge and this egg can replace those foods and our children have to raise very well." (EF, female)
"I don't have the capability to provide meat or fish to my children which have the similar proteins and vitamins like eggs. I know that eggs are important to children…" (EF, female)
"Yes, I don't have the capability to provide meat or fishes to my children and I think they have the similar proteins and vitamins like eggs. I know that they are important to children." (EF, female)

The general awareness of eggs as an important and nutritious food may have been the result of earlier large sensitization campaigns. During the last few decades, the government of Rwanda has launched several large campaigns to increase awareness about childhood malnutrition and educate rural farmers on steps to promote better nutrition. For example, the "Thousand Days in a Country of a Thousand Hills" nutrition

campaign, launched in 2013, mobilized communities to focus on the first thousand days of life as critical for preventing stunting and ensuring child growth and health.

In addition, since 1995, Rwanda has had a large team of volunteer community health workers who counsel, treat, and provide referrals to community members on a range of issues, including nutrition. Each of Rwanda's roughly 14,000 villages elects two women and one man to these posts, meaning that there is a small army of around 45,000 health workers. This human infrastructure has been essential in making dramatic improvements in maternal mortality and contraception use, and has likely increased the general knowledge about childhood nutrition. Therefore, it is likely that these efforts have increased the level of nutritional knowledge among typical rural families.

Affordability, in contrast, was cited frequently as a significant barrier to feeding eggs to children (see Table 4.4). The most common reason given by non-egg feeders for not feeding eggs to their children was a lack of funds. Not a single farmer interviewed reported routinely buying eggs in the market; though some reported occasionally buying eggs. Instead, most families raised chickens to produce eggs. However, many interviewees reported challenges associated with raising chickens (e.g. the expense of feed, theft by neighbors, expense of a chicken coop and predatory animals) or even getting the capital to afford buying a chicken in the first place (see Table 4.5).

Table 4.4: Interviewees' statements on the affordability of eggs/chickens

"If I am able to get the eggs, I could feed them with eggs because I really know it importance. The main difficult thing is to get the investment capital to buy the chickens" (NEF, female)
"Yes, when you have no chickens and the resources of money to use in affording them at markets and eggs are nowadays much more expensive than before. Getting the house (chicken coup) to keep them is too much expensive." (NEF, male)
"Even one egg is difficult, Imagine more? it is impossible. it is impossible to pay for them because I have no chicken." (NEF, female)
"We only consume them when there is an egg laying chicken, and I never think of buying them from the market when we have no egg laying chicken." (NEF, male)

Table 4.5: Interviewees' statements on raising chickens

"Getting the house to keep the chickens is still a challenge. … You can't let them go to find food (forage) by themselves. They can be stolen. (EF, male)
"(Chicken rearing is difficult) because they need veterinary, money for buying their food and this is hard for people from Village." (NEF, female)
"Chickens need food, to get money for buying their food is not easy, their treatment also is expensive" (NEF, female)
"Their foods are expensive and getting where to keep them safe (chicken coup) is too hard to and it require much money to build it" (NEF, male)
"Most of chickens are easily stolen and taken by eagles once they are left outside and even these ones that are kept inside the house, they get to our food which are costly. Plus, I do have 2 that I bought for this kid, but seriously, I know that thieves around here watch it grow day after another." (NEF, female)
"Thieves attack them very much. I started to raise them last year and they were 25. A thief stole 9 of the biggest ones when we were gone to work, so protection is very hard around here due to the availability of the market for them which attracts those thieves." (NEF, male)
"Poultry is a risky project which can fail totally due to certain cases like diseases attack. Prices for the chickens' food which are higher." (NEF, male)

Not only was overall affordability of chickens and eggs a commonly cited problem, but interviewees also highlighted the opportunity costs of feeding eggs to children (see Table 4.6). Many interviewees stated a preference for selling eggs in the market to buy more filling or calorie-dense food or for solving more immediate family issues.

Table 4.6: Interviewees' statements on the opportunity costs of feeding children eggs

‘‘I would rather sell eggs and buy Irish potatoes that will make my children full.” (NEF, male)
“They are not easily affordable, even for us who have egg laying chickens, we tend to sell most of them instead of feeding to the family.” (EF, female)
“To get eggs to feed my family, unless I raise chickens, I won't bother going to the market to buy them, since the money that I could use to buy those eggs can be used to buy other food that are enough to satisfy children.” (EF, male)
“You wouldn't feed the kids eggs just to eat like dinner. You sell and go and buy what they can eat and get enough” (EF, female)
“They (others) think that the eggs are the source of money rather than the food to help having better life” (EF, female)
“if you have 10 eggs means 800frw and this can be enough money to get family's food.” (EF, female)
“Families have many needs like paying school fees, and parents cannot care about eggs instead of those big challenges that they meet with.” (NEF, female)
“Most of the chicken's hosting they sell almost all eggs to help in solving other family issues which are requiring money to be solved such as in buying foods, health issues and so on” (NEF, male)

In sum, Rwandan farmers appeared to have the appropriate knowledge base to understand the nutritional benefits of feeding eggs to children, but they lacked the ability to do so due to lack of funds to purchase adequate amounts of eggs or chickens. In addition, the opportunity costs of feeding eggs to children was often seen as too high given competing needs.

Opportunity

When assessing the physical and social opportunity to feed eggs to children, we find that the opportunity to buy eggs is apparent, as most interviewees noted that they are readily available in market centers. However, opportunity is again thwarted by inability to pay for eggs or to find the capital to purchase chickens. Many interviewees complained of the expense at the market and noted that only wealthier farmers are able to feed eggs to children (see Table 4.7).

Table 4.7: Interviewees' statements on the availability of eggs

"They are not affordable because the egg is costing over the 100frs at shops and the people who are keeping livestock are few in our community." (EF, female)
"They are not that *affordable* for someone who do not raise chickens." (EF, female)
"For someone who raises chickens they can simply consume what they got from them, but few people around here tend to buy eggs from the market." (NEF, male)
"Eggs are so expensive that eggs now cost 120Frw, so I have a real way for my family to eat them and raise chickens for eggs that belong to my family and eat them. (NEF, male)
"Other families where they raise chickens tend to feed their family eggs, but for me, I don't think my wealth situation [regular food insecurity] allows it. (NEF, male)
"The eggs' eaters are those who have chickens at their house because other who could enjoy them have no money resources to buy them." (NEF, male)

Opportunity to engage in feeding eggs to children can also be thwarted by social and familial pressure. If influential community or family members disapproved of the practice, it would limit the felt opportunity for families to engage in that behavior. We did not find any such social pressures to refrain from feeding eggs to children in principle, and nearly all interviewees reported that family members understood the nutritional benefits and would not discourage this behavior (see Table 4.8). However, several interviewees noted that others would perceive them as rich if they fed eggs to their children. In addition, no interviewee reported any social taboos associated with feeding eggs to children, as is sometimes reported in other sub-Saharan African contexts (Chakona & Shackleton, 2019; Ekwachi et al., 2016). However, many interviewees did seem to think there was some risk of "overfeeding" children eggs, and they thought that a natural limit on what was acceptable for health was 2-3 eggs per week (see Table 4.9).

Table 4.8: Interviewees' statements about how family member perceive egg feeding

"They have no problem with this because they know it is best to feed the children eggs." (NEF, female)
"They are okay with me feeding my children eggs just as they could feed theirs, especially when there is a chicken that provide those eggs. But not buying them from the market." (EF male)
"In general, everyone understands the importance of feeding children eggs, and they do so to make their children feel better." (EF, male)
"People know that feeding children eggs is good and they love it, the only problem is getting them" (NEF, female)
"No Idea because I think they cannot take time to think about this, but if they will see me feeding my child eggs, they will say that I became rich." (NEF, female)
"Most of the time they think that my family life is more rich than theirs, and that it is the cause of feeding my children eggs" (EF, male)

Table 4.9: Interviewees' statements about feeing eggs once per day

"There is no need to feed them more eggs, just eating them in right amount, like 3 eggs per week are enough." (EF, male)
"No. I think eating few eggs is healthier than consuming a lot of them, because the more they consume a lot of eggs, the more they can face malnutrition diseases like obesity." (EF, female)
"The one who ate One egg is getting the same amount of proteins with someone who ate more than one and eating more could be a kind of mismanagement." (EF, female)
"They could be harmful to them buy feeling bad in their belly or getting over protein" (NEF, female)
"Eating many eggs can cause disease" (NEF, male)

Motivation (Lack of)

To understand what motivates caregivers to feed eggs to their children, it is important to consider both reflective and automatic motivation. Reflective motivation is the more deliberate process by which a person evaluates past behavior and makes future plans. Automatic motivation happens in the more "invisible" realm of our psyche which is governed by impulses and desires. To fully understand and design strategies to address

motivation, we asked farmers questions directly about their attitudes and motivations regarding feeding their children eggs, feeding them more generally, and we also asked broader questions about their overall aspirations, desires and values.

Overall, while interviewees reported a high understanding of the nutritional importance of eggs, they did not demonstrate that they valued feedings eggs to their children all that much. Eggs were simply seen as not all that essential amid competing priorities (see Table 4.10). As noted above, caregivers generally preferred selling eggs to buying more filling food or using the profits from eggs to attend to more immediate and sometimes unexpected expenses. Feeding eggs to children was simply not seen as all that valuable or essential, despite acknowledging some nutritional benefits. One interviewee summed this up succinctly saying, "We don't consume them a lot not because we don't have money to buy them, but because we consider them not that essential."

Table 4.10: Interviewees' comments on the value of feeding eggs to children

"It's not because I couldn't get him eggs; but because I don't think they are that necessary." (NEF, male)
"…not feeding eggs is matter of priorities and I think milk that I feed him is healthier than just one egg." (NEF, female)
"It is very difficult because money is not available to buy eggs because we have many needs in life and everything requires money." (EF, male)
"Everyone in our neighborhood has a plan for rewards; but many do not know the value of an egg to value it; they only value it by selling it. I have no problem" (EF, female)
"I don't think their nutritive value in terms of farmers' understanding matches exactly their size and price. For me in my family we don't consume them a lot not because we don't have money to buy them, but we consider them to be not that essential. (EF, male)
"The people who drink beer do not feed their children eggs. This will be easy for the people who do not drink because they do not sell eggs. The people who drink beer; they sell eggs and they go to buy beer; the ignorance." (EF, male)
"It depends on everyone's attitude because there are those who don't give eggs to the children, go to sell them and drink them (spend the profits from eggs on beer), and they don't care about the children and they don't forget their importance, but they just don't value them" (EF, female)

Beyond what motivates families to feed their children eggs, we wanted to understand what motivated their decisions when it came to feeding children more generally. When discussing their feeding practices, farmers expressed a desire to ensure that their children have good growth, health, and intellectual development (see Table 4.11). There was an overriding concern that children achieve the correct growth for their age (i.e., avoiding stunting, often referred to as "late growing"), and that good nutrition can help them achieve important long-term outcomes like doing better at school,

Table 4.11: Interviewees' statements on feeding their children

"It is necessary to feed him to grow better. The child who did not eat in good ways will grow later and start getting sick easily from many diseases and illness. He will fail at school if he doesn't get good diet in lower ages" (EF, female)
"I feed my children to help them growing up so that they would not face with the challenges of late growing, and I do not want my children to be hungry because it could push them to steal the neighbors' foods and this could be much ashamed to me and the whole family." (EF, female)
"Feeding a child is important because he is the Rwanda of tomorrow, so feeding him is to prepare him for a better future, Feeding a child is always something he has to eat and on time." (NEF, male)
"I think as young child who didn't get enough care while still a toddler, he needs to eat balanced diet to recover from that shortage, a balanced diet should be comprised of energy giving, diseases protecting, and body building food" (NEF, female)
"I feed my children to grow better and fast and avoid later growing in size and mentally, so to prevent all of these I try my best to provide fruits, eggs and vegetables" (EF, male)
"I feed my children to avoid them getting bad lives and late in growth in size and brains from not eating enough and balanced diet in their daily lives." (NEF, male)

To truly motivate families to change their behavior, it is important to look beyond nutrition and feeding to what motivates them more generally, what they aspire to and what they hope for their children. Many of the interviewees had personal narratives that were full of thwarted dreams and tragedies that had derailed their earlier life plans.

Given the average age of the interviewees, many of them were children or young adults during the devastating 1994 genocide, and it is hard to fully account for how that trauma may have affected their lives and outlook. One interviewee noted that her father was killed during the genocide which also ended her studies and displaced her family. Others made vague references to life changing events or life becoming more difficult after the genocide. Even those who did not recall events related to the genocide often reported that other tragedies changed the trajectory of their lives. One was left by her husband to care for seven children on a small plot of land. Some regretted being unable to complete primary school due to family hardship and tragedy. Another male interviewee was left with two young children when his wife was killed in an accident. A female interviewee lost both parents when she was 20 years old and was forced to rush into a marriage to have some social and financial support. When asked about what they hoped for themselves when they were younger, many spoke of aspiring to be professionals in health, education, government, or becoming religious leaders, and only two of the 32 interviewees mentioned wanting to be rural farmers (see Table 4.12). However, all the interviewees were currently making their living as rural farmers. In addition, many spoke with some sense of shame about what they were unable to accomplish, and saw their hopes for their children in contrast to what they were unable to achieve.

Table 4.12: Interviewees' statements contrasting hopes with personal regrets

"I hope my children will study up to the studies that I did not study" (NEF, male)
"I will pay them all schools level because I am not proud that I did not pass or get a chance of studying. I want them to be powerful persons." (NEF, female)
"Yes, we want our children to learn and grow because we do not want our children to be farmers like us." (EF, female)
"I hope for them to become healthier, as well as get educated to achieve what I have failed to." (EF, male)
Sometimes, it is hard to define dreams for the others when you have lost yours. I would be lying if I could say that I have yet started to define dreams for my children. (NEF, male)
"I feel like my baby will live better than I do' (EF, female)

When interviewees were asked about their hopes for their children, they focused on education as the main pathway to lives of security and stability (see Table 4.13). Paying for school fees and keeping children in school was a very high priority for interviewees. This goal makes sense in communities with high poverty and unemployment, in which the promise of even a relatively low but steady salary can be transformative. These parents' instincts are well justified by the data. Barouni and Broecke, have found that the returns to completing secondary school are 65% in Rwanda (when adjusted for unemployment), one of the highest in Africa (Barouni and Broecke, 2014). However, *enrollment* rates for secondary school are below 30% nationally and even lower in rural areas[12]. Education is the main vehicle out of inter-generational poverty in rural Sub-Saharan Africa, and interviewees pinned their hopes on their children's educational success.

[12] *"Education Statistical yearbooks". Rwandan Ministry of Education. MINEDUC*. Retrieved *September 28,* 2016.

Table 4.13: Interviewees' statements on their hopes for their children

"I will follow their school, how they will study. There is no other hope more than to become very strong through their knowledge." (EF, male)
"I will work very hard in order to get their school fees till they finish their class. I will increase my farming activities (EF, male)
"In general I try to save everything I have so that I can help my children go to school." (EF, male)
"I hope they get good education for the sake being able to be creative and fight from being unemployment." (EF, male)
"I wish my children would be the people who learnt different things and completed their studies. The great people who has the great partnership and collaboration in all." (EF, female)
"I hope for them to study and develop so much that two become doctors and one becomes a great policeman and the other a teacher." (NEF, female)
"My children have to study and be great people. (NEF, male)

In addition to the themes of personal regret coupled with hope for their children to achieve their dreams through education, we identified two other relevant themes. The first was a sense that shame, gossip, and others' opinions mattered to how interviewees behaved. Possibly due to the after-effects of genocide which ruptured the fabric of society, Rwanda ranks low on measures of social trust. According to the World Values survey, less than 5% of Rwandans agreed with the statement "most people can be trusted" in 2009 (Ortiz-Ospna & Roser, 2016). This compares with 17% in Mali and 40% in the United States in the same year. This relative lack of social trust can make societies more secretive and wary of others. This sense of secrecy and gossip manifested mainly when discussing how others perceive egg feeding, but also in other aspects of the interviews. Specifically, many interviewees noted that others would think them rich or living above their station if they started feeding eggs to children (See Table 4.14).

Table 4.14: Interviewees' comments on shame, gossip and how others perceive them

"I do not want my children to be hungry because it could push them to steal the neighbor's foods and this could be much ashamed to me and the whole family." (EF, female)
"if I have many chickens, sometimes people are not happy about my (large) production." (EF, male)
"People think that eating eggs and omelet is for rich families, so once they could find that we eat them every day, you would find that everyone in neighborhood would whisper around that we have gotten rich again like back in days when my husband worked from Uganda." (NEF, female)
"There are also some people who fear to buy them because of thinking that the eggs are for some people who are rich not for everyone." (EF)
"Most of the time they (neighbors) think that my family life is more expensive than theirs and that it is the cause of feeding my children eggs" (EF, male)
"In this site they think that to feed children eggs is for the rich only and they do not accept that everyone may eat eggs." (EF, female)
"(If I feed my children eggs) They can think that I have become rich, and it is a sign of showing them that I am superior to them." (EF, male)
"You know neighbors talk a lot, so anyone who know my living style and find me feeding my family eggs, would wonder where I got that richness from." (NEF, male)

A second prominent theme was the value interviewees placed on hard work (See Table 4.15). When asked about who they most admired in their community and why, they focused on themes of hard work and industriousness. They admired people in their lives who persevered in the face of adversity through diligence and hard work.

Table 4.15: Interviewees' comments on who they admire and why

"I know someone in my generation. She is orphan (she had no father) her mother married another man, and she became HIV Positive, That girl really studied and she became a teacher in primary school, She combined this with agriculture and she took decision of helping her mother. She took care for everything." (NEF, female)
"In my life my role model is my mother because she has always encouraged us to work hard so that we can achieve something." (EF, female)
"One person I took as an example was the Director of the school I attended, but he died. She set an example for me because she loved work, she set an example for me to love work" (EF, female)
"In my life the person I take as an example is my husband who lives with me because he does his best to make the home development. We were married and we had nothing, but together we worked, and he woke up early and went to the rice patty we are developing, and we are still in good shape no problem." (EF, female)
"I do admire my father because his deeds impressed me. He is a carpenter and he worked hard to manage his family to the extent that all of his children finished high school, and he used to be example to all of us." (EF, male)
"I think I wish to be like (name withheld, who is in agriculture. H has a banana field, rice field and 5 cows. He is landlord, and he has many farms. He is very rich because even until now he work very hard. (EF, male)

In sum, the main themes associated with *capabilities* were a strong awareness of nutritional benefits, but a challenge in raising chickens or affording them in the market. Eggs were generally available in the market, and we found no real social pressure against feeding eggs, so there was some *opportunity* available, but this was again curtailed by the costs of eggs, as well as the opportunity cost of feeding eggs to children. Finally, *motivation* to feed eggs was thwarted by the generally low value placed on eggs. A deeper look into what may motivate caregivers more generally found that caregivers have high hopes for their children to live better lives than they were able to live, generally through education. Interviewees also emphasized the value of hard work and hinted at the power of peer pressure/gossip. In the next section, I discuss how we used these themes to develop the study interventions.

Intervention Development

Because the barriers to child egg consumption are multi-faceted, we wanted to design a multi-pronged approach. Our analysis found that, despite the relatively common practice of chicken rearing and the general awareness of the heath and nutritional benefits of egg consumption, caregivers were not commonly feeding eggs to children because of (1) the lack of access to affordable and plentiful eggs and (2) a lack of perceived value in feeding such an expensive food product to their children. In terms of access, almost no interviewees were buying eggs, and, instead, relied on the eggs produced from their own chickens, but they also found chicken rearing quite challenging due to the expense of the feed, the need to build housing and the threat of predators and thieves. The lack of perceived value in feeding children eggs was largely because eggs can command a high price at the market and the profits from egg selling could buy more calorie-dense food or could be used to attend to other family needs. A summary of how these barriers and opportunities map on to the COM-B framework is present in Table 4.16.

Table 4.16 COM-B framework

	Barriers	**Opportunities**	**Strategy**
Capabilities	Challenge in raising chickens/ affording eggs	knowledge of nutritional benefits	Poultry Arm: Training on chicken rearing
Opportunities	Lack of opportunity to purchase chickens Eggs have high opportunity costs	Chickens are common Eggs are available at market centers	Poultry Arm: Poultry on credit Poultry + SBCC[13] Arm: Increasing perceived benefits relative to costs
Motivation	Lack of perceived value Present bias (assumed)	Commitment to children and their educational attainment	Poultry + SBCC Arm: Increasing perceived value, reducing present bias and increasing salience.

[13] SBCC = Social Behavior Change Campaign consisting of radio messaging, text message reminders, limited in-person training and posters to hang in participants' homes.

The interventions we tested in this study address both aspects of lack of access and lack of motivation (See Table 4.17 below). The first arm (poultry), which provides chickens on credit along with training on chicken rearing, addresses the lack of access to chickens that can survive well in the rural context. One Acre Fund provides participating farmers with Sasso chicken varieties which are bread to thrive on foraged food rather than purchased seed, so they are quite hearty in rural areas and less expensive to raise because farmers do not need to purchase feed. The program also provides training on how to construct chicken coops and provide better care for chickens to ensure their survival. Before providing the chickens to families, the chickens are also vaccinated for Newcastle disease (a common and highly contagious disease with no cure), infectious bronchitis, Marek disease and infectious bursal disease. Participants are able to select the number of chickens they need based on their credit tolerance from a minimum of two chickens to a maximum of fifteen, but the average adoption was 3.5. The chickens cost $2.46 each including interest.

To address the motivational challenges, we devised a multi-pronged social behavior change campaign (SBCC) based on the barriers and themes identified in this formative research. The second arm included both the poultry program as well as the SBCC campaign (poultry + SBCC). Structuring the interventions this way allows us to test whether access alone (poultry arm) is sufficient to improve egg feeding, or if access along with behavior change (poultry + SBCC) is required. The SBCC was comprised of daily radio spots that include narratives, expert testimony and peer testimony, regular text reminders, limited in-person training and posters which hang in participant homes. In-person training was greatly curtailed due to COVID-19 restrictions, which likely

diminished the overall impact of the intervention. Instead of conducting group trainings, as planned, the 63 field officers were trained remotely on the benefits of feeding eggs, provided with training guides and visuals, and instructed to train farmers one-on-one. However, given their other duties as One Acre Fund field officers, they were quite time constrained and were likely unable to reach all intended families.

Table 4.17: Description of intervention arms

Poultry Arm	**Poultry + SBCC**
• **Sasso improved chickens on credit** • **Training on chicken rearing**	• Sasso improved chickens on credit • Training on chicken rearing • Exposure to radio campaign • Text message reminders • Limited in-person training • Posters to hang in participant homes

The motivational challenges to feeding children healthy, but more expensive food is not a problem unique to the Rwandan context. Well-informed and motivated consumers the world over struggle to make healthy nutritional food choices for themselves and their children, even when they can afford it. Consumers are plagued with a number of behavioral biases that thwart their efforts to make good nutritious choices, such as present bias, inertia, lack of salience, habit and the avalanche of advertising for less nutritious food. There is also the additional challenge in the Rwandan context that eggs are indeed financially precious, meaning that it will be tempting to sell eggs in order to purchase cheaper and more calorie-dense food such as beans or maize flour, especially if eggs are not perceived as valuable. Another challenge is that if the benefits of better eating accrue a long time in the future, it can be difficult to prioritize them amid more pressing or immediate concerns – a present bias in which future benefits are greatly

discounted. Finally, it is possible that feeding eggs to children simply lacks salience to the patterns of farmers' lives. Cooking and feeding children are very habitual activities, particularly in the rural context with a narrower range of available meals. Any behavior change message needs to be highly salient and frequent to induce changes in patterns of behavior. In the sections below, I outline the communication vehicles we used to deliver the behavior change messages, and I then describe three key behavioral levers we address through the social behavior change campaign.

Behavior Communication Vehicles

The main vehicle of the behavior change messages was through community three-minute radio segments "spots" (nine per day for five months), which included short narrative dramas, testimonials, and expert call-in shows. Radio is a very popular means of information gathering in Rwanda. While I was unable to find official statistics on radio listenership nationally, the baseline survey of over 2000 respondents conducted for this trial found that 83% of respondents listened to the radio, and three-quarters of those who did listen daily. The radio messages were reinforced through in-person One Acre Fun training conducted by One Acre Fund Field Officer staff[14]. The messages were also reinforced by regular text message reminders (four per month, on average) and posters which were distributed to farmers to hang in their homes.

Narrative or stories have been shown to be a very effective vehicle for behavior change. Research has shown that people remember stories at much higher rate than simple facts or pieces of information, and also that stories that evoke emotional arousal

[14] One Acre Fund Field officers serve on average 400 farmers and are responsible for agricultural training and collection of input loan repayment.

can enhance the long-term memory of the content even further (Heath & Heath, 2007; Cahill & McGaugh, 1995). The power of narrative has been shown to be effective in behavior change in public health contexts in Sub-Saharan Africa specifically. For example, an MTV drama called Shuga, inserted educational storylines about HIV/AIDS, and led to increased HIV testing, reduced risky sex and even fewer sexually transmitted infections among women (Banerjee et al., 2018). A meta review of educational entertainment (often dramas) on health outcomes found a significant effect on persuasion which was consistent across location, media vehicle (e.g. TV, radio) and across outcomes (Shen & Han, 2014). To capitalize on this power of storytelling, I worked with the One Acre Fund Radio Team to develop radio spots that included short narratives (see Appendix B) featuring relatable characters, some of whom were initially quite resistant to feeding eggs to children. One radio spot, for example, features a couple with a skeptical husband who would rather sell eggs to buy potatoes and a wife who wants the best future for her children, who are having a discussion with their neighbor - a community health worker - who slowly convinces the husband that eggs are a good investment.

The radio spots and the in-person training also capitalize on the power of metaphor, which serves to elucidate new topics by comparing them to what is familiar. Metaphors, like stories, can be powerful vehicles for persuasion. Sopory and Dillard outline six theories as to why metaphors are persuasive, ranging from the "pleasure or relief" view that states that the semantic anomaly contained in a metaphor leads to psychological tension which is later released when meaning is decoded, to the theory of "superior organization" which states that metaphors better structure an argument than literal language, and are thus more persuasive. (Sopory & Dillard, 2002). In their meta-

analysis, these authors find that metaphors did influence attitude change, and that this effect was intensified when a single non-extended and novel metaphor was used. Other experimental research has shown that a speech concluded with extended metaphors elicited more desired attitude change than speeches with literal conclusions (Bowers & Osborn, 1966). Each radio spot ends with the message, "If we can invest in fertilizer to help our plants grow, we should invest in our children to give them the best chance at a successful life." This uses a single vivid relatable metaphor for an audience whose livelihoods are centered around farming.

Another powerful vehicle for persuasion is that of testimonials from similarly situated peers. There is evidence that people both absorb information more deeply and are encouraged to act on that information when they receive it from those in their social network. Social cognitive theory states that people learn from observing another and use queues from their counterparts and environment to process information (Spahn et al., 2010). Testimonies can also help create a social norm around a novel behavior (Tabanico & Schultz, 2008). The socio-ecological model of behavior change views individual decisions as embedded in multiple spheres of social and environmental influences which exert powerful influence on those decisions (McLeroy, et al., 1988). Therefore, the radio campaign included regular "testimonials" from families in their community who had started feeding eggs to their children and found their children to be thriving. These testimonies were aired monthly for two weeks after each radio spot.

In addition to the power of peer testimonials, messages carry a lot of persuasive weight when they are delivered by trusted experts. In their guidance on using mass media in public health, Griffiths and Knutson point out that communication is likely to be

most effective if the person communicating the message is perceived as an expert or holds some prestige (Griffiths & Knutson, 1960). They add that local health leaders may be better able to capture opinion than national leaders of great stature who lack experience in the local area. This insight has been confirmed in more recent years with various mass media campaigns. A recent study found that text messages from experts were more effective in sparking an initial change in exercise than text messages from peers, but peers were more important later on in the adoption cycle to encourage the behavior (de Vries et al., 2017). This campaign to promote egg feeding of small children included radio spots called "expert corners" in which local health and nutrition experts responded to pre-recorded questions from area residents. These were short three-minute spots which aired nine times a day for one week a month. The campaign also included expert spots, which were 30 minute shows, aired twice a month in which experts, such as Ministry of Health Officials answer more detailed question in a moderated discussion.

Behavior Change Levers/ Messages

Based on the formative research, as well as a review of the literature, we centered the SBCC around three key behavior change levers. First, we sought to increase the perceived value of feeding eggs to children by emphasizing eggs as a "superfood," associating the activity with an act of love, associating it with an aspirational activity/source of positive gossip and by commiserating about the challenges. We also sought to address caregiver's present bias by making the future pay-off of improved childhood outcomes, particularly related to education, more front-of mind. Finally, we

attempted to increase the salience of egg feeding through visual cues (posters) and regular reminders (text messages).

Perceived Value

Perceived value is the flip side of expense. There are many items which, when introduced, seemed unaffordable to smallholder farmers. A good example is cell phones. While initially thought to be unaffordable, the value in terms of connectivity and information has meant that families found the funds and made it a priority to purchase phones, as evidenced by the relatively high cell phone adoption in rural areas in Rwanda. (Less than 10% of the population had cell phones in 2006 and this ballooned to over 75% in 2015, according to World Bank Data[15].)

Initial qualitative work has demonstrated that farmers simply don't see the value in eggs commensurate with their price, despite knowing some of the basics about the nutritional benefits. So, the value will have to be clearly and compellingly demonstrated. Therefore, the first pillar of the behavior campaign was attaching a greater sense of value to eggs. In exchange theory parlance, we were seeking to increase the associated benefits of the behavior change.

Based on the themes identified in the formative qualitative work, we identified the following messages to convey across multiple channels including radio, in-person training, posters and SMS reminders.

(1) *Eggs are a superfood*. Many farmers view eggs as a luxury food – expensive and not necessarily essential for healthy child growth. So, the campaign described eggs as a "superfood" whose benefits are extraordinary and should

[15] https://data.worldbank.org/indicator/IT.CEL.SETS.P2, Retrieved Oct 27, 2021

be considered less of a luxury and more of an essential food for good child development. Messaging emphasized the high protein in eggs, similar to even more expensive foods such as meat and fish, and the unique nutrients which promote brain development.

(2) *Eggs as a demonstration of love*. Rwandan parents, like parents the world over, have great affection for their children, and work hard to provide them a better life than they had. Emotional hooks, such as love, are incredibly powerful motivators in any behavior change campaign (Turner, 2012). So, this campaign, through imagery and narrative connected feeding eggs to young children as an act of love.

(3) *Feeding eggs as a source of pride / aspirational*. As noted above, in a secretive society, such as Rwanda, gossip (both positive and negative) can permeate village life. A recent mass media campaign in Indonesia was developed based on the idea that child feeding behavior was greatly influenced by family and peers, and used a "healthy gossip" technique of portraying characters gossiping both about good and poor child feeding practices (White et al., 2016). The intervention in Indonesia resulted in statistically significant improvements in dietary diversity for those exposed to the campaign. Our campaign was designed to similarly capitalize on this dynamic by showing images of people whispering to one another in admiration of other caregivers who had successful outcomes from their children due to eating eggs. An example of this from the radio campaign had two community members discussing their neighbor: "Even our neighbor

Maria, she started adding eggs to her children's meals just last year, and already she has seen the benefits, her children are so much healthier and their teachers in school even say how much better their performance has gotten."

(4) *Acknowledging the challenges*. No behavior change campaign can be successful if the consumers of the campaign feel it is out of touch and does not understand their challenges. In this case, the primary challenges are around raising chickens, affording eggs and the temptation to sell them when they are available. Therefore, the radio messages and training all explicitly acknowledged these challenges at the same time as they made the case for feeding eggs to children. Much of the radio dialogue included statements about the challenges of affording eggs or successfully raising chickens. This was also encapsulated by the poster message (more below): "Eggs are precious, but so is my child." Addressing the large monetary value of eggs acknowledged it is not easy to spare them, but then contrasted this with the promise of a bright future for the child.

Present bias

One barrier to egg feeding is likely a strong future discounting. While parents may know that regularly feeding eggs will help their child grow and thrive, they may fail to change their behavior because those benefits are far off in the future and families may have more immediate concerns. A key insight of behavioral economics is that humans engage in hyperbolic discounting, which means that we greatly prefer immediate benefits to those in the future, even if future benefits are much larger. However, much of the behavioral economics lab work has been conducted on a very narrow range of Western

educated subjects, and more recent evidence suggests that non-Western populations might be even more present-biased (i.e. discount future benefits even more). For example, Wang, Rieger and Hens used a large-scale international survey of economics students across 45 countries to examine how the various cultural dimensions affect time preferences (Wang, et al., 2011). They find that participants from countries with higher GDPs and higher growth were more willing to wait for higher returns (e.g. they were less present biased) than those in countries with lower GDP/growth. They also find that cultural factors influence time preferences even when holding interest rates constant. One survey question asked interviewees if they would prefer to have $3400 this month or $3800 next month. Of the eight regional groups, Germanic Nordic was the highest with nearly 90% preferring to wait, but African was the lowest with only 34% willing to wait (Wang et al., 2011, pg. 18). In addition, countries that have a higher pace of time (e.g. value punctuality and work speed) are less likely to be present biased. African cultures tend to have a slower pace of time, and also have greater present bias.

It is not just cultural proclivities that influences time preferences. Hausofer and Fehr conducted a meta study looking at the influence of poverty or deprivation on time preferences and found a consistent pattern in which poorer household make more present-based decisions. (Hausofer & Fehr, 2014) The authors, both neuro-economists, propose yet another causal pathway: stress. Those living in poverty are less likely, due to stress, to exhibit will power or self-control. They cite one study that primes randomly selected subject to complete a budget with either a surplus of money or poverty wages. Those in the poverty wages category subsequently did worse on tests of will power. Taken together this recent research supports the idea that it can be particularly difficult for low-

income, rural African farmers to make decisions that have pay-offs long into the future. This makes a certain intuitive sense as well. If the future is more uncertain and immediate needs quite pressing, as is often the case in low-income societies with recent political instability, investing in a long-term future pay-off is rarely as tempting as addressing a more immediate need.

To help address this present bias, the behavior change campaign drew explicit connections with investments in feeding eggs today and future pay-offs. The campaign tied feeding eggs to greater educational attainment, the outcome most highly prized by Rwandan parents. Several of the radio spots emphasized the importance of the nutrient choline found in eggs which supports brain development, and many of the settings were in the school or preparing children for school. One of the radio spots was set in a school meeting in which parents were discussing with teachers the value of feeding eggs to children. The in-person trainings also contained images of children in school uniforms. The message on the poster (more below) read, "Eggs are precious but so is my child. Eggs have protein and nutrients which help his/her[16] brain development" which again ties this investment in a highly prized future pay-off of better success in school.

Salience

Another barrier to egg feeding is salience. Amid a host of other pressing concerns, remembering the importance of feeding eggs or thinking of it daily can be lost. Both future discounting and salience were addressed in this marketing campaign by making the future benefits more concrete through visual reminders, and through regular reminders via text message. While these may seem like small nudges, there is at least

[16] Kinyarwanda has only one pronoun for both genders

some evidence that they can be quite effective. A study in Zambia, for example, compared the following groups: (1) a group that received monthly nutrition education meetings and nutritional supplements, (2) a group that only had child growth charts hung in their homes to monitor growth, (3) a control group, which received no intervention (Fink et al., 2017). Surprising even to the researchers, the results showed that the growth chart group had both the best improvements in stunting and also the best feeding practices. In collecting qualitative data to help interpret this unexpected finding, researchers found that one of the main things participants liked about the chart was that it included images of children who will be successful later in life (the poster included an image of a young woman in a graduation gown). It is also likely that the constant visual reminder helped the messages remain more salient than monthly meetings. We therefore sought to provide a constant visual reminder to families to reinforce the messages from the mass media campaign.

Rural Rwandan farmers commonly proudly display calendars hanging in their homes, often in the main room. We pre-tested several images and selected the one that most directly addressed a main barrier of feeding eggs to children– their opportunity costs – but also contrasts this with love of the child and hope for their future, as it was the most preferred and most memorable. The poster reads "Eggs are precious but so is my child. Eggs have protein and nutrients which help his/her[17] brain development," and is accompanied by a picture of a mother looking lovingly at her small child who is smiling and holding an egg (See Figure 4.3). Families reported that this image was most

[17] There is no gender-specific pronoun in kinyarwanda

emotionally evocative and also most memorable. All families in the poultry + SBCC arm were assigned to receive these large (12" by 16.5") calendar posters.

In addition to the poster, we sent regular text message reminders that reinforced messages of the campaign and sought to drive more listeners to the radio program (see Appendix D).

Figure 4.3: English version of egg promotion poster

Drawing on the insights gained during the in-depth formative research as well as from behavioral science, we developed a multi-pronged behavior change campaign to increase the perceived value of eggs to caregivers. This campaign relied on narratives, metaphors and testimonials from experts and peers, all of which have evidence supporting their efficacy. The campaign also attempted to address present bias by making the long-term benefits, particularly around educational achievement, more noticeable and attempted to make the act of egg feeding more salient with text message reminders and posters to hang in families' homes. The campaign centered around themes of eggs as a "superfood", love for children and hope for their future success and aspiration to be a model member of the community, but also acknowledged the real challenges of raising chickens and producing enough eggs to feed them to children. Before presenting the results of the impact evaluation, in the next chapter we discuss the instrument used to assess and capture social desirability bias, which could be a factor in respondents' self-reports of egg consumption.

Chapter 5: Social Desirability Bias

Social desirability bias (SDB) occurs when respondents seek to present themselves in a favorable light according to social norms and standards (Zerbe & Paulhus, 1987). Social desirability may be motivated by seeking out social approval or avoiding social disapproval (Bornstien, 2015). Researchers, and evaluators in particular, should be especially concerned about SDB when conducting evaluations that rely on respondents' self-reports, particularly if the intervention they are evaluating might exacerbate this bias. For example, interventions that attempt to change norms, like behavior change campaigns, might also change the psychic benefits of a positive survey response.

Failing to account for SDB may lead to under- or over-estimating program impacts or misunderstanding mediating mechanisms. However, many studies that rely on self-reported data, do not attempt to control for this form of measurement error. Van de Mortel conducted a review of 14,275 health-related studies that used survey data, and found that only 31 (0.2%) used a social desirability scale (van de Mortel, 2008) to help measure and control for SDB. Of those who did control for social desirability, nearly half (43%) found that it influenced their results. The most commonly administered scale, the Marlowe-Crowne Social Desirability Scale, (M-C SDS) was created in 1960 using data on Western undergraduates. In recent years, this scale has been administered in Sub-Saharan Africa, but there is little consensus on whether it is a valid instrument across cultures. In this dissertation, the validity of the scale applied to a rural East African population was assessed, using a large sample of respondents across two survey rounds.

In this chapter, I discuss the theory underling social desirability bias, the M-C SDS, it's applications, and constructs. I then examine the research testing this scale across cultures, and in Africa in particular. Finally, I present the results from administering this scale to a large sample of rural Rwandan respondents across two survey rounds, assess the scale's reliability and validity, and examine the underlying constructs using exploratory factor analysis.

Social Desirability Bias in Surveys

Social scientists have developed a four-stage cognitive model whereby respondents process and respond to survey questions (Sudman, Bradburn, & Schwarz, 1996). In the first three stages, respondents interpret the question in front of them, search for relevant information in their memory, and formulate their response. In the fourth stage, their "true" survey responses are evaluated and sometimes modified in either a conscious or subconscious process, prior to reporting. It is in this fourth stage that social desirability may influence survey responses.

Many theorists have argued that social desirability is a personality characteristic related to conformism and found that it varies across people (Johnson & Van de Vijver; Crowne & Marlowe, 1960). As such, it is possible to measure and control for this tendency in social science generally, and in program evaluation research specifically, which often relies on survey data to assess the effectiveness of an intervention.

The existence of social desirability bias in survey responses has been well established in the social science canon. For example, multiple studies find that people tend to over report their engagement in socially valued activities, such as voting (Silver, Anderson, & Ambramson, 1986) and hand-washing (Contzen, 2015), and to underreport

activities which are undesirable or stigmatized, such as substance abuse (Mensch & Kendel, 1988; Adong et al., 2019), engaging in unprotected sex (Stuart & Grimes, 2009) and employing children as laborers (Jouvin, 2021). These studies match self-reports with other sources that better reveal true behaviors, and social desirability bias appears to be rather universal, with studies spanning multiple countries and regions.

Marlowe Crowne Social Desirability Scale

The Marlowe Crowne Social Desirability Scale (M-C SDS) is the most commonly used scale to assess social desirability (Johnson and Van de Vijver, 2003; Vu et al., 2011). Moonnan and Podsakoff conducted a meta-analysis and found that over 90% of the research at that time that had used a social desirability measure relied on the M-C SDS (Moonan and Padsakoff, 1992).

David Marlow and Douglass Crowne developed their scale by writing a set of 50 statements that were associated with socially desirable and undesirable thoughts or behaviors and then giving them to 10 judges, including faculty and graduate students at Ohio State University to rate them as socially desirable (Crowne & Marlow, 1960). The statements included those that were socially desirable but rather uncommon (e.g. "I am always courteous, even to people who are disagreeable"), and statements that were socially undesirable but more common, (e.g. "On occasion I have had doubts about my ability to succeed in life."). From this initial list, the 33 statements that best discriminated between overall high and low scores were retained as the M-C SDS (See Table 5.1). In administering this scale, respondents are asked whether each statement is either true or false for them. The items are scored where a 1 indicates a socially desirable response, which is marked "true" for the socially desirable items and a "false" for the

socially undesirable items, and a 0 indicates the opposite. A higher total score indicates a higher propensity to engage in social desirability bias.

Table 5.1: Marlowe-Crowne Social Desirability Scale

	Original Marlowe-Crowne statements	**Included in the Short Form-C**
1	Before voting I thoroughly investigate the qualifications of all the candidates	
2	I never hesitate to go out of my way to help someone in trouble	
3	It is sometimes hard for me to go on with my work if I'm not encouraged	X
4	I have never intensely disliked anyone	
5	On occasion I have had doubts about my ability to succeed in life	
6	I sometimes feel resentful when I don't get my way	X
7	I am always careful about my manner of dress	
8	My table manners at home are as good as when I eat out in a restaurant	X
9	If I could get into a movie without paying and be sure I was not seen I would probably do it	
10	On a few occasions, I have given up doing something because I thought too little of my ability	X
11	I like to gossip at times	
12	There have been times when I felt like rebelling against people in authority even though I knew they were right	X
13	No matter who I'm talking to, I'm always a good listener	X
14	I can remember "playing sick" to get out of something	
15	There have been occasions when I took advantage of someone	X
16	I am always willing to admit it when I make a mistake	X
17	I always try to practice what I preach	
18	I don't find it particularly difficult to get along with loud mouthed, obnoxious people	
19	I sometimes try to get even rather than forgive and forget	X
20	When I don't know something I don't at all mind admitting it	
21	I am always courteous even to people who are disagreeable	X
22	At times I have really insisted on having things my own way	
23	There have been occasions when I felt like smashing things	
24	I would never think of letting someone else be punished for my wrong-doings	
25	I never resent being asked to return a favor	
26	I have never been irked when people expressed ideas very different from my own	X
27	I never make a long trip without checking the safety of my car	
28	There have been times when I was quite jealous of the good fortune of others	X
29	I have almost never felt the urge to tell someone off	
30	I am sometimes irritated by people who ask favors of me	X
31	I have never felt that I was punished without a cause	
32	I sometimes think when people have a misfortune they only got what they deserved	
33	I have never deliberately said something that hurt someone's feelings	

Source: Crown & Marlow, 1960; Reynolds, 1984

In the 60 years since its creation, the M-C SDS Scale has been used frequently, particularly in Western countries. The scale has achieved internal reliability scores

ranging .73 to .96, but these were generally assessed in samples of undergraduate students (Rischer & Fick, 1993; Loo & Thorpe 2000; Barger, 2002). It has also been found to be negatively correlated with self-reports of socially undesirable behaviors, such as alcohol use and academic cheating (Welte & Russel, 1993; Adong et al., 2019; Bernardi & Adamitis, 2006).

Because the M-C SDS is rather long, at 33 statements, there have been various attempts to shorten the scale. The earliest attempt was by Strahan and Gerbasi, who developed three shorter forms, one with 20 and two with 10 statements, but only the 20 statement form had an alpha greater than .7 (Strahan & Gerbasi, 1972). Reynolds created three shorter forms containing, 11, 12 and 13 items, and the 13 item scale, termed Short Form C, is the most commonly used today. (Reynolds, 1982).

There have been multiple attempts to evaluate the validity and internal consistency of the M-C SDS short forms, and no decisive narrative has emerged. In 1992, Ballard evaluated the available scales as well as her own new 11, 12 and 13 item scales, and she found that internal consistencies in her own and Reynold's short form ranged from .63 - .70, but that the full scale was only .75, so she recommended the shorter scales as suitable substitutes (Ballard, 1992). Conducting a similar assessment, Fischer and Fick found in a sample of 360 University students a vastly higher internal consistency, ranging from .86 to .94 and recommended some shorter forms as superior to even the original scale (Fischer & Fick, 1992). Loo and Thorpe asserted that all of the short forms were an improvement over the original 33-item form in terms of goodness of fit, but they found lower internal consistency ranging from .42 - .68 (Loo & Thorpe, 2000). Barger assessed the full range of available short form scales across two samples of

undergraduate students (n= 466 and n= 431), and also found relatively low internal consistency, ranging from .45 - .72, but reached a different conclusion than Loo and Thorpe, and discouraged the use of these shorter forms (Barger, 2002). Barger notes that goodness of fit for the shorter forms is most likely attributed to the less demanding estimation inherent with fewer variables, and goodness of fit is potentially a statistical artifact.

All the shorter forms of the M-C SDS were developed through experimentation with university students in North America or the UK, and subsequent tests of their internal consistency were also conducted with university students. More recently, Sarbescu and coauthors tested the full scale, as well as a 21 item and 13 item M-C SDS on a sample of 215 Romanian subjects aged 20-35, and found that all had internal consistency greater than .7 (.78, .79, and .75 respectively), and that both short versions achieved better fit than the original scale (Sarbescu et al., 2012). They concluded that short forms were adequate in measuring social desirability. There is no consistent or consensus view on the reliability of the shorter forms, though they remain in common use.

There is also some doubt about whether the scales (both the full M-C SDS and the shorter forms) represent one underlying construct or multiple constructs. Marlowe and Crowne initially claimed that their scale was measuring a single trait of the need for approval, and many shorter forms were created based on this assumption (i.e. using principal components analysis to identify the factors most associated with the first factor). Some theorists, have identified two underlying psychological mechanisms driving social desirability bias. However, multiple social scientists have since used

exploratory and confirmatory factor analysis to identify two or more underlying constructs. Notably, Ramanaiah and coauthors found underlying constructs that they termed "attribution" (attributing socially desirable traits to oneself) and "denial" (denying undesirable traits) (Ramanaiah et al., 1977). However, other studies have found different underlying constructs. Working with a sample of 511 undergraduates, Paulhus found that the two underlying factors did not fit the attribution and denial framework, and instead suggested that self-deceptive enhancement (SDE), or the tendency to inflate positive aspects of oneself, even to oneself, in a self-delusional way, and impression management (IM), the tendency to present oneself in a socially acceptable manner were the constructs that better fit the data (Paulhus, 1984). A more recent study, drawing on an international sample of French-speaking African students and Swiss students found two underlying factors that did not fit those constructs (Verardi, et al., 2010. Instead, the data from this study found that survey responses clustered around the concepts of achievement or inter-personal relationships (Verardi et al., 2010). Other studies have also found at least two underlying constructs in factor analyses, and there is no clear consensus on what those underlying constructs entail (Ballard, 1992, Barger, 2002; Fischer & Fick, 1993; Loo & Thorpe, 2000; Leite & Beretvas, 2005; Verardi et al., 2010).

Cross-Cultural Differences

The majority of research devoted to both developing and vetting instruments of social desirability has been conducted in Western and largely English-speaking countries, despite the fact that these countries represent a small proportion of the world's population (Bornstein et al., 2015). The populations generally studied, often university undergraduates, present an even narrower slice of the countries of study, making the

results even more idiosyncratic to those subpopulations. Further complicating matters, Henrich argues quite convincingly, that Western, educated, industrialized, rich democracies, are just as their acronym states: WEIRD (Henrich et al., 2010). When compared with the global distribution of a number of characteristics, WEIRD countries are at the tails of those distributions. For example, people from WEIRD countries value interpersonal relations less, have high levels of individualism, tend towards overconfidence, and rely more on analytical thinking rather than holistic approaches to problem solving much more than the global averages. Therefore, it is highly probable that the tendency to exhibit social desirability response bias will vary by culture, and that instruments designed to measure it in one culture will be sub-optimal when applied to others.

There is a considerable empirical evidence that social desirability varies among cultures, and that people in collectivist cultures exhibit more social desirability than those in more individualist cultures. In their review of social desirability in cross-cultural research, Johnson and van de Vijver find that collectivist values are more associated with a tendency to present oneself in a socially appropriate manner, maintain relationships, and save face, but that in individualist societies people are more concerned with honesty, and seem relatively freer from some of those social pressures (Johnson and van de Vijver, 2003).

Several large cross national studies have confirmed an association between collectivist societies and social desirability. Comparing social desirability scores among students from 12 countries (Australia, Canada, China, Colombia, Ecuador, Hong Kong, Ireland, Japan, Nepal, South Africa, Spain, and the United States) Bernadi found that, on

average, a country's social desirability decreases as individualism increases (Bernadi, 2006). In one of the more ambitious studies to date, Van Hemert and co-authors examined data applying four scales of the Ensenck Personality Questionnaire across 24 countries, and they found a negative correlation between the Lie Scale (another measure of social desirability) and Gross National Product and other wealth indices, which are also correlated with individualism (Van Hemert et al., 2002). Middleton and Jones conducted two studies comparing US and Eastern (those born in East Asia) students on both the long and shorter forms of the M-C SDS, and found in both studies that Eastern subjects, from more collectivist cultures, were more likely to both deny socially undesirable traits and to claim social desirable traits (Middleton and Jones, 2000).

Adding a bit of nuance to the relationship between culture and social desirability bias, Lalwani, Shavitt and Johnson tested the hypothesis that individualist societies would exhibit more SDE (presentation of honestly held but inflated self-images), and that more collectivist societies would exhibit more IM (inflating socially prized characteristics) (Lalwani et al., 2006). They found that participants from Singapore, a more collectivist society, did in fact score higher on SDE and lower on IM in social desirability than those in the more individualistic United States. Similarly, a cross-country comparison study in which nearly 3,500 university students from 20 countries completed a modified version of the M-C SDS found nuanced results for how culture affects the different underlying constructs of SDB (He et al., 2015). The authors found a 2-dimensional structure in the pooled sample, which reflected what they termed enhancement (similar to the concept of attribution discussed above) or denial (rejection of undesirable behavior). However, interestingly, the authors found that there was more cross-cultural variation in the denial

factor than in the enhancement factor, and that the Human Development Index (a measure of a country's state of economic and human development) was negatively correlated with the denial factor. The authors ultimately conclude that social desirability should be considered as a culturally regulated response.

Focus on Sub-Saharan Africa

While the M-C SDS was developed and tested on Western samples, it, especially the Short Form C, has in recent years, been applied to understand, assess, and control for social desirability in African populations. Several studies applied the M-C SDS to assess the validity and reliability of the scale across cultures and included African samples in that assessment. One study modified the full scale to 28 questions, omitting those which were least culturally relevant, and administered it to youth in Kenya, Mozambique, Ethiopia, and Uganda (Vu et al., 2011). The researchers found reliability estimates between .63 and .8 and concluded that the M-C SDS could be effectively used to measure and control for social desirability bias in the region. Other studies included African countries in their cross-country comparisons of social desirability as measured by the M-C SDS Short-Form-C, and similarly concluded that the scale worked to confirm social desirability as a rather universal construct (Bornstien et al., 2015; Williams et al., 2006).

However, there have been conflicting findings of cross-national differences when applying the M-C Short Forms. One study used the MC Short Form-C to compare French-speaking Africans across 8 countries and Swiss respondents (Verardi et al., 2010). In this study, the reliability of the Short Form-C ranged from .54 to .75 in the African countries, and exploratory factor analysis uncovered two underlying factors, which did not fit the attribution and denial constructs, and instead more closely fit achievement and

interpersonal relationships. The authors conclude that this scale should not be used to assess social desirability bias in cross-cultural studies as it did not reach scalar equivalence.

Other researchers have attempted to validate the M-C SDS scale with data on lying in African countries. A study set in Uganda tested whether SDB impacted self-reports of alcohol use among HIV-infected adults, using bio-markers that detected if the respondent had consumed alcohol in the prior three weeks (Adong et al., 2019). The study found that among those who had bio-marker indication of prior alcohol use, those with the highest M-C SDS scores also had decreased odds of reporting any recent alcohol use. However, this relationship was not statistically meaningful ($p=.34$), and the internal consistency of the M-C SDS was only .44 in the population. An earlier study, also conducted in Uganda, with a similar population and similar goal of understanding under-reporting of alcohol use, found that M-C SDS scores were *not* related to those who were identified from bio-markers as lying about their alcohol consumption and those who were not (Muyindike et al., 2017). The authors also found a relatively low reliability of the M-C SDS of .49.

Other researchers have used the M-C SDS as a control for social desirability in African samples; however, not all studies report the scale's reliability or if the social desirability scores affected the outcome (Kekibina et al., 2021; Ofori, et al., 2019). For example, Hayes-Larson and co-authors used M-C SDS as a control variable when examining the correlates of depressive symptoms and harmful alcohol use in Lesotho (Hayes-Larson et al., 2017). However, they did not report the reliability of this scale or if including the SDB measure affected their results. In their study of infant and child

feeding practices in Ethiopia, Kim and co-authors found that positive feeding practices were not correlated with MC-SDS scores, and they concluded that social desirability bias did not impact their results (Kim et al., 2016). However, they did not report the reliability of the scale in their sample, and so it is possible that SDB was uncorrelated with their outcomes because the scale was not reliably measuring social desirability.

Overall, the M-C SDS scale has been administered in relatively small samples in Africa, and the studies do not conclusively find that the scale is reliable or correlates with confirmable respondent bias. In addition, many of the studies have been conducted on relatively younger, more urban and slightly more educated samples (See Table 5.2 for a summary of studies that applied MC-SDS on African populations and also reported the SDS score or the reliability estimate). The reliability estimates vary widely from .44 to .80 with a median of .62. In addition, the studies that conducted factor analysis found that there are at least two underlying structures to the scale. So, it is still not clear that M-C SDS is an appropriate tool for measuring and controlling for SDB in rural African populations, though it's use has emerged in African context in the past fifteen years.

Table 5.2: Marlowe-Crowne SDS in African samples

Source	Country	N	Target population	Education	Age[1]	Self-administered/ interviewer	Cronbach's Alpha	Mean SDB score	type of MC
Vu et al., 2011	Kenya	113	Never-married participants in an HIV prevention campaign	63% primary; 32% secondary	15-24	Interviewer	0.63	15.7	28 items scale
Vu et al., 2011	Mozambique	114	Never-married participants in an HIV prevention campaign	59% primary; 39% secondary	15-24	Interviewer	0.66	20.6	28 items scale
Vu et al., 2011	Ethiopia	114	Never-married participants in an HIV prevention campaign	43% primary; 48 % secondary	15-24	Interviewer	0.8	19.5	28 items scale
Vu et al., 2011	Uganda	114	Never-married participants in an HIV prevention campaign	67% primary; 33% secondary	15-24	Interviewer	0.7	15.5	28 items scale
Bornstein et al., 2015	Kenya	97	Mothers and fathers of 8 year old children	Not disaggregated by country	Not disaggregated by country	self-administered	not reported	8.35	Short Form C
Adong et al. 2019	Uganda	751	HIV-infected patients	67% less than secondary; 33% secondary or more	median age - 31	Interview	0.44	9	Short Form C
Verardi et al., 2010	Benin	203	Literate in French	98.6% had secondary school degree (in full African sample)	median - 23.7	self-administered	0.56	8.09	Short Form C
Verardi et al., 2010	Burkina Faso	210	Literate in French	same as above	median age - 26.9	self-administered	0.64	7.99	Short Form C
Verardi et al., 2010	Mali	240	Literate in French	same as above	median age - 26.8	self-administered	0.54	7.74	Short Form C
Verardi et al., 2010	Senegal	238	Literate in French	same as above	median age - 32.9	self-administered	0.57	9.02	Short Form C
Verardi et al., 2010	Democratic Republic of Congo	220	Literate in French	same as above	median age - 29.4	self-administered	0.54	8.04	Short Form C
Verardi et al., 2010	Republic of Congo	187	Literate in French	same as above	median age - 32.6	self-administered	0.61	8.32	Short Form C

Source	Country	N	Target population	Education	Age[1]	Self-administered/ interviewer	Cronbach's Alpha	Mean SDB score	type of MC
Verardi et al., 2010	Mauritius	236	Literate in French	same as above	median age - 31.9	self-administered	0.75	7.69	Short Form C
Hayes-Larson et al.,	Lesotho	371	TB HIV patients	69% primary school or less	median age - 35	Interviewer	0.8	not stated	Short form C
Kekbina et al., 2021	Uganda	421	HIV positive adults who are on antiretroviral therapy and are self-reported drinkers.	78% had primary education or less	median age - 40 years	Interviewer	not reported	18-20	28 item scale
Vu et al., 2013	Ethiopia	114	youth, aged 15-24	37% had some secondary education or more	14-24	Interviewer	0.8	not reported	28 item scale
Muyindike et al., 2017	Uganda	104 and 198	HIV-infected adults who denied alcohol use	not reported	median age - 32	Interviewer	0.49	8.9 and 9.1	Short form C
Hale and Fields, 2007	Ghana	60	Working adults (93% male) studying in a Christian seminary	not reported	Mean - 34.5	self-administered	not reported	not reported	short from 13 Q
Ofori et al., 2015	Ghana	172	Student athletes	University	mean - 24.11	self-administered	0.56	6.63	Short From C
He et al., 2015	Kenya	157	University students	University	mean - 22.04	self-administered	not reported separately	4.06 (enhance) 3.01 (denial)	Modified MC - 15 questions, looked at denial and enhancement separately
He et al., 2015	South Africa	166	University students	University	mean - 19.68	self-administered	not reported separately	4.16 (enhance) 2.80 (denial)	same as above
He et al., 2015	Togo	201	University students	University	mean - 22.48	self-administered	not reported separately	4.00 (enhance) 3.22 (denial)	same as above

1. The data presented on age was based on what the study provided

The present study affords us an opportunity to investigate the validity and reliability of the M-C SDS Short Form C across a large sample of rural East African respondents. Not only does this dissertation have a larger sample than all previous studies that have administered the MC-SDS on African samples, but I had the opportunity to administer the questionnaire to the sample twice (at round 1 and then six months later at round 2) to the same respondents in order to conduct a test-retest reliability assessment.

The MC-SDC was administered as part of this study assessing the effectiveness of a social behavior change campaign encouraging greater feeding of eggs to small children, an intervention that has been shown to have large nutritional benefits. The respondents were all participants in a social enterprise that supports smallholder farmers with farming inputs on credit and was running the behavior change campaign. The survey rounds took place in 3 districts, in different geographic regions of the country, and the sample size was 2,232 respondents who were found across both rounds. Respondents were the caregivers of children under 5 in the household, three-quarters of which were women. The median age of the survey respondents was 37, and 17% had any secondary education.

The M-C SDS was administered at the end of a survey asking about child feeding practices by trained enumerators. The survey questions were translated into Kinyarwanda and then back-translated and checked for consistency of meaning. The statement about rebelling against authority was deemed a bit sensitive given Rwanda's political environment, so that question was moved to the end of the survey module. The round 1 results found rather low reliability (alpha = .38), so enumerators were retrained the survey was re-administered at a second data collection round six months later.

To investigate this internal consistency and the underlying constructs of this instrument, I calculated the Cronbach's alpha for both survey rounds, estimated correlations between test and re-test responses, estimated the correlation between SDB scores and the outcome of interest (egg consumption), and conducted exploratory factor analysis to assess the number and nature of underlying constructs.

Results

Table 5.3 presents the raw summary statistics from each response statement from round 1 and round 2. No other studies of African respondents have presented these summary statistics, so it is hard to assess if these are generally in line with the typical responses. However, several questions had above 95% of respondents responding in the affirmative, so those statements may be less useful for differentiating characteristics in the population. Overall, I find fairly similar results between round 1 and round 2, on average. Most means were within 3 percentage points of the other round's score. However, two questions elicited about 10 percentage points more affirmative responses between the two tests. Both of these statements were unique in that they had the word "never" in them, may have been confusing to respondents. I therefore emphasized to enumerators that they pay special attention to this word (i.e. not deviating from the translation) in the second administration of the survey. Interestingly, positive responses to those questions went up after this correction (e.g. even more people said they "never deliberately hurt someone's feelings."). Such negative survey statements or question wording has been shown to lead to poor survey response (Johnson et al., 2004; Chyung et al., 2018), and some have found that negatively worded items can emerge as a separate

construct in factor analyses, creating problems for construct validity and reliability (Chyung et al., 2018; Ye & Wallace, 2013).

Table 5.3: Summary statistics from M-C SDS across 2 rounds of data collection (limited to those respondents who were surveyed across both rounds)

Items	**Round 1**	**Round 2**
Sample size	*2232*	*2232*
It is sometimes hard for me to go on with my work if I am not encouraged	75.10%	78.80%
I sometimes feel resentful when I don't get my way	95.40%	94.40%
On a few occasions, I have given up doing something because I thought too little of my ability	89.20%	84.90%
No matter who I'm talking to, I'm always a good listener.	97.00%	96.20%
There have been occasions when I took advantage of someone	17.60%	21.40%
I'm always willing to admit it when I make a mistake	76.90%	78.10%
I sometimes try to get even rather than forgive and forget	19.20%	18.10%
I am always courteous, even to people who are disagreeable	95.60%	93.80%
I have never been irked when people expressed ideas very different from my own	75.50%	85.00%
There have been times when I was quite jealous of the good fortune of others	89.00%	84.70%
I am sometimes irritated by people who ask favors of me	16.40%	14.90%
I have never deliberately said something that hurt someone's feelings	78.30%	87.90%
There have been times when I felt like rebelling against people in authority even though I knew they were right	22.30%	27.10%

Despite the fact that the overall survey response averages were quite similar across survey rounds, the test-re-test correlation Pearson's correlation coefficient was low (.351), and the average SDB scores were different between the two rounds (p=.000) (See Table 5.4). However, when I removed the two questions with the "never" statements, the correlation increased (.425) and the SDB score averages are nearly identical (6.44 & 6.44; p=.980). The test appears to be reliable *at the sample level*, with the removal of the two questions with the "never" statements, as the scale averages were identical across

rounds. However, the scale did not meet the test-retest reliability threshold at the person level since the correlations are far below an acceptable level (Cozby & Bates, 2012).

Table 5.4: Round 1 and Round 2 M-C SDB results and correlations

	Round 1	Round 2	Pearson's Correlation	t-test
M-C SDB (full 13 questions)	7.98	8.17	0.351	0.000
M-C SDB (11 questions)	6.44	6.44	0.425	0.980

The average social desirability scores are generally in line with those of other studies conducted with African populations, which ranged from 6.63 to 9.02 with a median of 8.09. Some studies have also found gender differences between respondents, with men scoring higher than women in African samples (Verardi et al., 2010), but other studies have found women scoring higher than men in Western samples (Barger, 2002, Bernardi, 2006), and some studies have found no gender differences at all (Loo & Loewen, 2004; Vu et al., 2011; Bornstein, 2015). However, most studies of the M-C SDS reviewed here had relatively small sample sizes at the country level. In both rounds of this study I found that men scored higher than women, though in the first round this difference was more pronounced and more statistically meaningful (round 1, male: 8.25, female, 7.86, p=.000, round 2: male: 8.28, female: 8.13, p=.064).

In this study, the internal consistency of the scale was low, ranging between .383 and .397 for the full 13 statements and .387 and .454 after removing the negatively worded statements (See Table *5.5*). This is lower than what other researchers have found working with African samples (See Table 5.2). However, in two

studies run in Uganda both internal consistency estimates were below .5 (Adong et al., 2019; Muyindike, et al., 2017). An alpha below .7 is generally not considered adequate (Cortina, 1993),

Table 5.5: Internal consistency estimate for Round 1 and Round 2

	Cronbach's alpha
Round 1 (13 questions)	.383
Round 1 (11 questions)	.380
Round 2 (13 questions)	.397
Round 2 (11 questions)	.454

If SDB is influencing self-reports, it should correlate with the outcome of interest. In this study the behavior change campaign was encouraging egg consumption among young children, so the reported egg consumption might be influenced by participants' desire to sound positive, which could result with respondents reporting increased egg consumption. However, I find very little evidence of the full scale or the 11 question scale (removing negatively worded questions) is correlated with egg reporting. There was almost no correlation whatsoever with the SDS scores and reported egg feeding (Pearson's correlations coefficient = .0137). Even when using a SDS excluding the negatively worded questions, the correlation is almost non-inexistent (.0318). This low relationship could be due to the fact that respondents did see feeding eggs to children as a socially desirable action, ar did not feel this strongly enough to influence their responses. This is certainly a possibility since the radio program used to promote egg feeding behavior had relatively low listenership. However, it is possible that the scale simply did not adequately measure social desirability in this sample. It is that possibility that I turn to next.

Exploratory Factor Analysis

I conducted exploratory factor analysis to assess the number and nature of underlying constructs in the SDB scale for this rural Rwandan sample. An examination of item correlations to check for possible multicollinearity problems indicated that none of the correlation coefficients exceeded .7, so I retained all 13 items for analysis in both round 1 and round 2. Data were normally distributed with no outliers and there were minimal missing data (3-4%). A principal components analysis with varimax rotation was conducted on the 13 items. For round one, five eigenvalues of sample correlation matrix were greater than 1, with values (and percentage of variance explained) of 1.54 (12.7%), 1.49 (11.5%), 1.29 (10.0%), 1.07 (8.2%), and 1.01 (7.8%). All factors together explained 50.2% of the variance. For round two, five eigenvalues of sample correlation matrix were greater than 1, with values (and percentage of variance explained) of 1.79 (13.7%), 1.57 (12.5%), 1.28 (9.9%), 1.10 (8.4%), and 1.05 (8.1%). All factors together explained 52.3% of the variance. Scree plot analysis also suggested retaining 5 factors. (See Table 5.6 for the factor loadings.)

Table 5.6: Factor loadings from exploratory factor analysis for Round 1 and Round 1

	Standardized factor loading Round 1					**Standardized factor loading Round 2**				
	1	2	3	4	5	1	2	3	4	5
There have been times when I felt like rebelling against people in authority even though I knew they were right	.663					.660				
I am sometimes irritated by people who ask favors of me	.607					.615				
I sometimes try to get even rather than forgive and forget	.562					.602				
There have been occasions when I took advantage of someone	.482					.589				
I have never been irked when people expressed ideas very different from my own		.814					.786			

I have never deliberately said something that hurt someone's feelings	.817			.801		
On a few occasions, I have given up doing something because I thought too little of my ability		.665			.701	
It is sometimes hard for me to go on with my work if I'm not encouraged		.714			.723	
There have been times when I was quite jealous of the good fortune of others			.788			.793
I sometimes feel resentful when I don't get my way			.682			.693
I'm always willing to admit it when I make a mistake			.738	.608		
No matter who I'm talking to, I'm always a good listener.			.558	.553		
I am always courteous, even to people who are disagreeable			.552	.749		

The identification of five factors makes these results quite out of step with prior studies. The five factors do not seem to fit into any pattern of social desirability previously identified (e.g., attribution or denial; achievement or interpersonal relationships). Instead, the factors identified in this study appear to cluster around basic personality traits. For example, the first factor includes the four statements that might be most associated with someone who is more anti-social (e.g.: I rebel even though authority is correct, I'm irritated by people who ask favors, I have sometimes try to get even rather than forgive, I have occasionally taken advantage of someone). The polite statements (I'm always a good listener, always courteous, sometimes admit making a mistake) also cluster together. As others have found, the two negatively-worded questions formed their own factor. So, while the factors are logically clustered, they do not cluster in a way that would suggest any of the previously identified constructs of social desirability. Overall, the low internal consistency and the fact that the underlying constructs are not aligned

with any of the concepts associated with social desirability indicates that the M-C SDS Short Form C is not an appropriate scale to measure SDB for this population.

In the next chapter, I present the results from the impact evaluation of the egg promotion trial. I do control for social desirability bias, as measured by the M-C SDS as I had intended to. However, because there was little correlation between the outcome of interest (difference in number of times eggs consumed per week) and the M-C SDS score and the scale has low internal consistency, I do not expect controlling for social desirability in this way to influence the results.

Chapter 6: Results

Baseline Results

In terms of basic demographic characteristics, I found some notable differences between all three districts at baseline data collection (See Table 6.1). This is to be expected. Because I was not able to randomize treatment and am instead using a difference-in-difference methodology, we can tolerate some differences in sample populations, as long as their trajectories in terms of the primary outcome of interest are moving in parallel.

The biggest difference and largest area of concern is the difference in the percent of respondents who are female, which was higher in the comparison area and the poultry-only area than it was in the poultry + SBCC area. This was a result of the survey administration. The survey protocol asked the enumerator to find the household member who was the "primary caregiver" of the child. I had assumed that this would mean the mother in most circumstances, who in Rwanda is the person to most often prepare food. However, we discovered part way through data collection that many men were describing themselves as the primary caregiver and were thus the main survey respondent. In hindsight, it would have been better to have asked "who is the person most responsible for preparing food for the child to consume?" I caught and corrected this error part way through data collection. However, at that point a greater number of respondents in Gisagara had been surveyed. That is why the percentage of male respondents in Gisagara is higher.

We might worry more about this if reported consumption patterns were correlated with the respondent's gender. However, subsequent analysis found that reported egg

consumption is uncorrelated with the respondent's gender. Further, enumerators reported that when they were interviewing male heads of household about child feeding practices, the respondents regularly consulted with their wives. As a point of comparison, male respondents had major differences from female respondents in terms of land size and assets. But diet in general, and egg consumption in particular, were not correlated with gender.

Respondents in the three districts differed on some other demographic characteristics. Comparison area respondents were slightly younger (two years). Household size was the largest in the poultry-only area. Respondents from the comparison group had slightly smaller reported land size than those in the other districts, and also owned fewer cows. There were differences in the age of the youngest child across districts, but these were small in magnitude. In order to assess relative wealth status, we collected information about each household's Ubudehe status. In Rwanda, Ubudehe is a tiered assignment of wealth that is designated based on participatory poverty assessment conducted by consensus with village councils. Ubudehe entails a ranking households on a one through five scale, with a one indicating the household is in the greatest need of assistance. The question on Ubudehe status was left off of the baseline collection and only collected at the endline survey. However, Ubudehe designations had not changed during the duration between baseline and endline surveys and so we can consider it a time invariant characteristic for the purposes of this study. Respondents in the pure comparison area ranked slightly lower than those in the other districts, with an average Ubudehe designation of 2.25.

Many of the above differences had very low p-values according to Kruskal-Wallis tests, indicating that there were differences among at least two of the three groups. However, the magnitude of many of these differences was still quite small. For example, while the Kruksal-Wallis p-value was .0003 for Ubudehe status, the actual differences between the groups were between .03 and .09 points. The study arms did not have statistically or numerically meaningful differences in the gender of the youngest child, likelihood of being married and in percent of respondents who completed some secondary education.

Table 6.1: Demographic characteristics by study arm

	Poultry + SBCC	Poultry-only	Compromised Comparison	Kruksal-Wallis test, p-value
Sample size	781	737	779	
Percent Female Respondent	56.7%	75.2%	72.9%	.0001
Age	39.42	39.75	37.26	.0001
Household size	5.71	6.66	5.50	.0001
Number of cows	0.79	0.55	0.66	.0001
Percent with Phone	84.9%	95.5%	85.1%	.0001
Land size (ares - 10x10 m)	41.41	39.65	29.21	.0001
Ubudehe (poverty category)	2.38	2.35	2.27	.0003
Percent Married	92.3%	90.8%	90.9%	.7094
Percent with Some Secondary Education	20.9%	15.9%	16.0%	.1018
Child Age	2.74	2.61	2.91	.0052
% Female (child)	49.4%	49.5%	50.2%	.9087

The baseline survey data also show that there were important differences between the districts in terms of chicken ownership and egg buying behavior (See Table 6.2). Again, this is to be expected because the baseline was conducted *after* the chickens were distributed in the poultry-only and poultry + SBCC districts. Respondents in these

districts had between 2.5 and 2.7 more Sasso chickens (the type that One Acre Fund distributes) than those in the comparison district. Respondents in One Acre Fund poultry districts also reported having more chickens of other varieties. In terms of production, however, respondents in the poultry-only district, actually reported more eggs produced per chicken, by nearly 1 additional egg per week. At the flock level, production patterns were reversed, with respondents in the poultry-only and poultry + SBCC districts reporting that they produced more eggs per flock than those in the comparison area, due to their larger flocks. Across all districts, very few respondents reported buying any eggs (7.9%) in the past week. All of these differences between the three districts had very low p-values according to ANOVA F-tests, except for the number of eggs laid per week per flock and the percent of respondents who bought eggs in the prior week.

Table 6.2: Chicken ownership and egg buying behavior by study arm

	Poultry + SBCC	Poultry-only	Compromised Comparison	F-test, p-value
Sample size	*786*	*788*	*775*	
Number of Sasso variety	3.24	3.07	0.53	0.000
Number of Village/local variety	0.90	0.82	0.42	0.000
Number of laying hens	0.04	0.13	0.02	0.000
Number of broilers	0.11	0.43	0.02	0.000
Number of unknown variety	0.05	0.25	0.01	0.000
Total chickens	4.18	4.55	0.90	0.000
Total laying chickens	4.07	4.15	0.89	0.000
Eggs per chicken per week	2.39	2.41	3.30	0.001
Number eggs laid per week (per flock)	9.82	9.82	7.92	0.480
Percent who bought eggs last week	7.63%	8.84%	7.23%	0.469
Number of eggs bought last week (among those who bought)	3.02	4.01	2.61	0.020

Enumerators administered a 3-day food frequency questionnaire in which respondents were asked how many times the youngest children under 5 years of age but over 6-months consumed various categories of commonly consumed food groups (See Table 6.3). Among all food groups, the most commonly consumed were beans, green vegetables and porridge, which were all consumed at least 3 times in the last 3 days. There were differences among districts with respondents in the poultry + SBCC district reporting that their children consumed beans more frequently but potatoes less frequently. Respondents in the comparison district reported that their children ate less rice, meat, fish and eggs but more sweet potatoes than the other districts. According to respondents in the poultry-only district, their children consumed more green bananas, fruit and green vegetables. Notably, children in the two One Acre Fund poultry districts were already consuming more eggs at baseline compared to the pure control district. However, consumption was still low in those districts (.4 times per 3 days). The differences all had very low p-values according to ANOVA f-tests. However, egg consumption was not statistically different ($p=.20$) between Gisagara and Rusizi according to a two-tailed t-test.

Table 6.3: 3-day food frequency (number of times each food was fed to the child) by study arm

	Poultry + SBCC	Poultry-only	Compromised Comparison	F test, p-value
Sample	*786*	*756*	*778*	
porridge	2.74	3.45	2.70	0.000
bean	6.70	3.76	4.24	0.000
rice	1.48	1.25	0.28	0.000
potato	0.43	0.98	2.53	0.000
sweet pot	1.45	2.06	3.05	0.000
bread	0.44	1.26	0.47	0.000
fruit	1.45	2.02	1.17	0.000
green veggies	3.73	4.91	3.09	0.000
meat	0.21	0.25	0.06	0.000
egg	0.39	0.44	0.09	0.000
fish	1.40	1.85	0.33	0.000
nuts	0.05	0.03	0.01	0.164
cassava	1.05	1.41	0.22	0.000
banana	0.57	1.03	0.18	0.000
maize	1.39	1.64	1.83	0.000

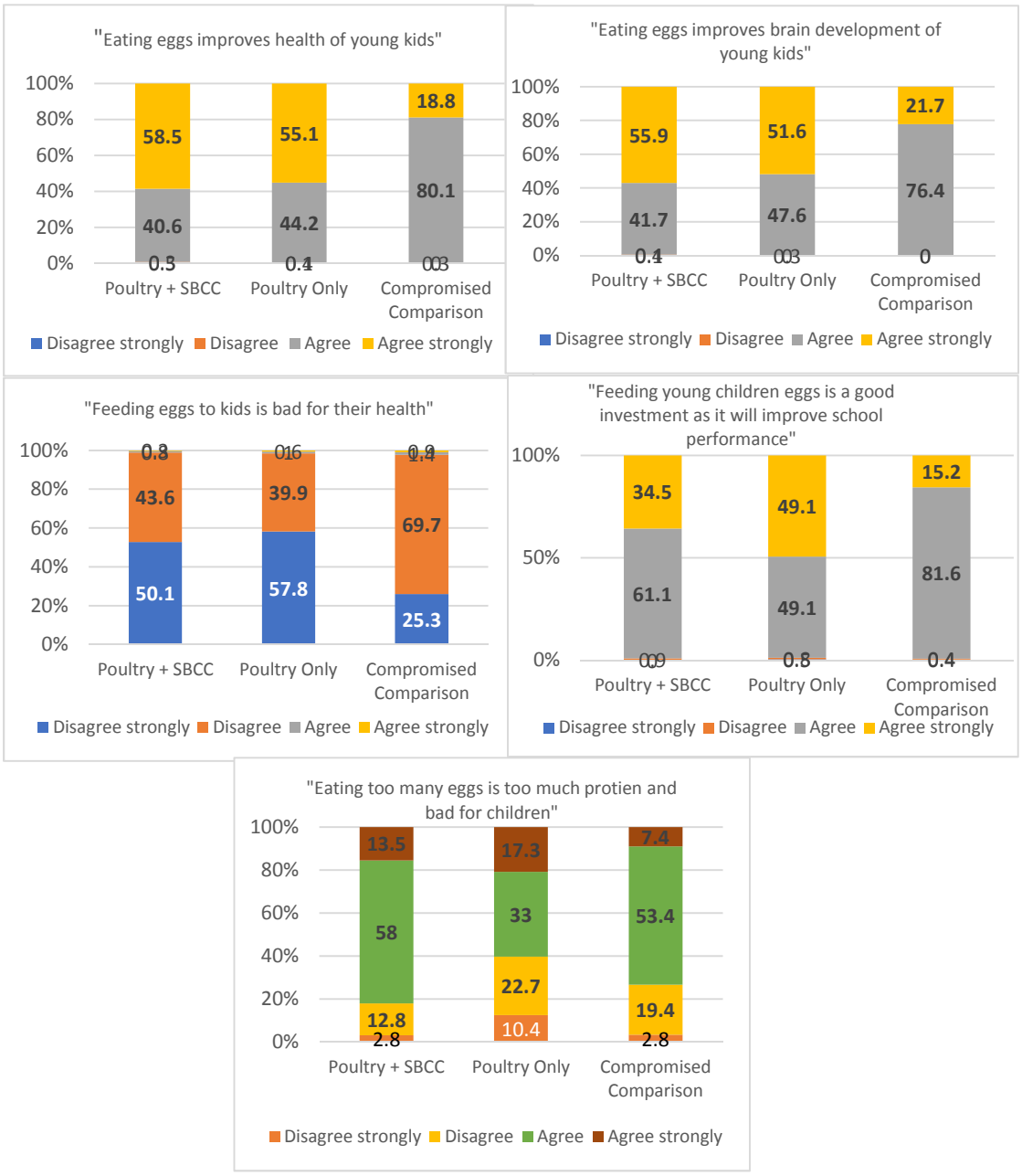
A longer recall period allows us to better understand the dietary consumption patterns of children, particularly among foods which are eaten less frequently. Therefore, respondents were also asked about egg, meat and milk consumption in the past 7 days. Here too we see similar patterns with respondents in the One Acre Fund poultry districts reporting that their children consumed eggs about twice as frequently as children in the control district and consuming meat about 4 times as frequently (See Table 6.4). However, reported levels of milk consumption was roughly equal among districts, with children in the poultry-only district consuming slightly less, which makes sense since respondents in that district also reported fewer average cows per household. The differences among districts had very low p-values, according to ANOVA F-tests.

Table 6.4: 7-day food frequency by study arm

	Poultry + SBCC	Poultry-only	Compromised Comparison	F-test, p-value
Sample	*785*	*762*	*784*	
Meat	0.41	0.52	0.12	.000
Eggs	0.78	0.61	0.26	.000
Milk	1.90	1.53	1.90	.039

Finally, respondents were surveyed on their knowledge and attitudes about chicken raising and feeding eggs to their children. Overall knowledge of the benefits of egg consumption was quite high across all districts, with most respondents agreeing or strongly agreeing with the statements that eating eggs improves the health and brain development of children, and disagreeing or strongly disagreeing with the statements that men, rather than children, should eat eggs or the eggs are bad for children's health (See **Error! Reference source not found.**). However, respondents in One Acre Fund poultry districts were more likely to offer more emphatic responses (e.g. strongly agree) than the respondents in the comparison area. Therefore, it may have been hard to increase this knowledge over the course of this study. The one exception is in the statement asserting that too many eggs provide too much protein, which is bad for children. The majority of respondents across all districts agreed or strongly agreed with this statement (50.3% - 71.5%), but a significant minority (12.8%-17%%) said they did not know.

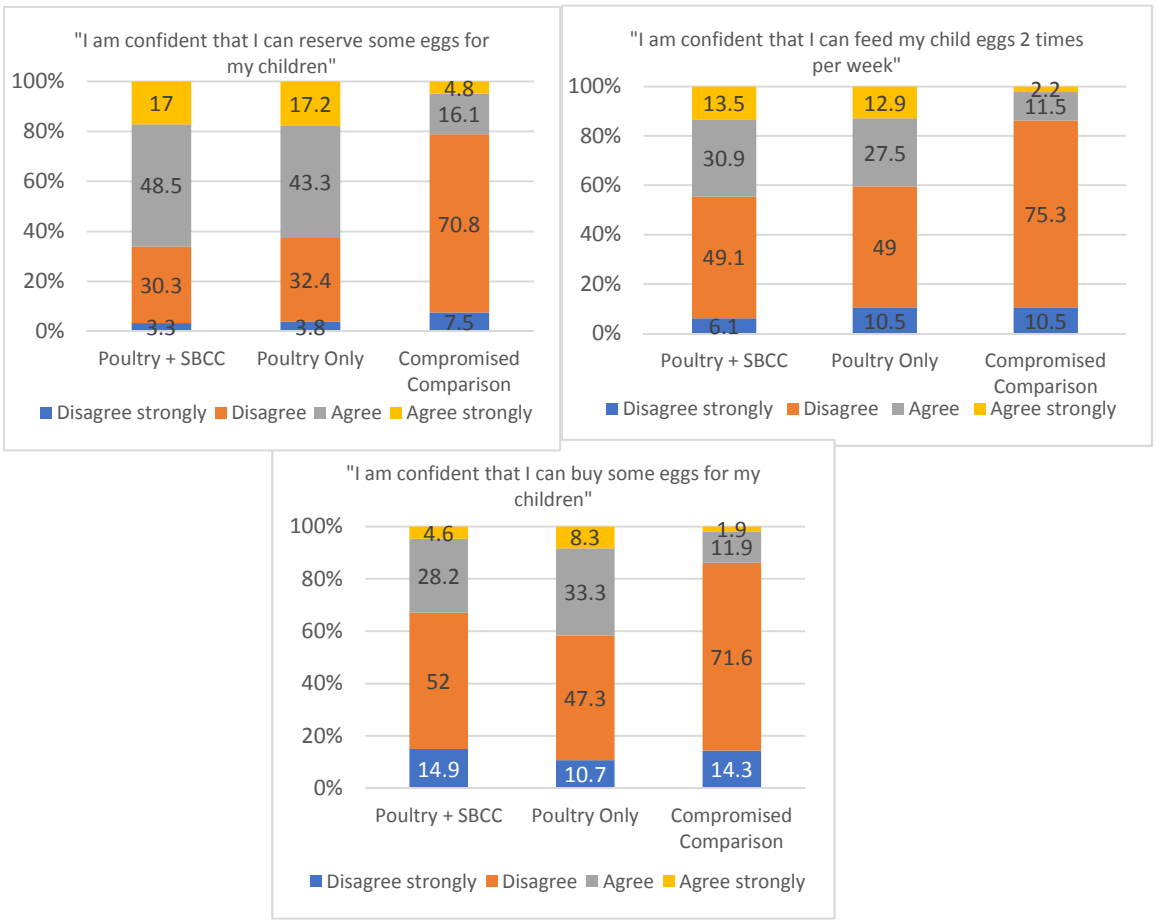
Figure 6.1: Percent of respondents who agree with knowledge statements, by district



Overall, respondents were a lot more confident in their ability to feed children eggs from their chickens, rather than buying them, and a majority of respondents (58% - 86.8%) across all districts disagreed or strongly disagreed with the statement asserting confidence in buying chickens (See

). In addition, the majority of respondents across all districts were not confident in their ability to feed children at least two eggs per week. However, there were important differences among the districts. Respondents in the poultry districts were more likely to agree with statements asserting their confidence in their ability to feed eggs to their children from chickens they raise (65.5% and 60.5% vs 20.9%) and had more confidence at baseline that they could feed their children eggs two times per week (44.4% and 40.4% vs 13.7%). So, it does appear that there is already greater knowledge of egg benefits and perceived ability to feed eggs to children at baseline in the One Acre Fund poultry districts relative to the comparison district. This could be because there was some messaging to One Acre Fund poultry-adopting families encouraging them to feed eggs to their children when chickens were distributed before the baseline survey. This greater knowledge among families in the One Acre Fund poultry districts could hamper the ability to further improve this knowledge relative to the comparison district throughout the trial.

Figure 6.2: Percent of respondents who agree/disagree with attitude statements by study arm



Exposure to Treatment

In terms of the exposure to the poultry intervention, in the poultry + SBCC district, 5,563 One Acre Fund clients elected to purchase Sasso chickens and receive training, and they took on an average of 3.24 chickens. In the poultry-only district, 3,243 elected to purchase Sasso chickens, and they took an average of 3.35 chickens. All farmers who elected to purchase, received six-week old chickens between January and March of 2021. In the past, One Acre has found that about 25% of chickens die before

maturity due to sickness and predators. One Acre Fund could not guarantee that all chickens were hens rather than roosters, so not all of them would eventually lay eggs. It would take until about July (or 1 month into the radio campaign) for the earliest hens to start laying eggs. Sasso eggs are expected to lay about 1 egg per day.

Exposure to the social behavior change campaign was rather limited both due to anticipated and unanticipated reasons. Just under half of the respondents in the poultry + SBCC district reported having heard the radio campaign at all. Of those who did, two-thirds only heard the radio spots 10 or fewer times, despite the spots airing nine times per day for five months (See Figure 6.3). This low exposure was somewhat anticipated.

Radio Rwanda, the national radio channel, is vastly more popular than any community radio station. Baseline survey data found that 84.2 % of respondents listened to Radio Rwanda as their first or second choice and only 18.5% listened to Radio Salus as their first or second choice. However, Salus was still the most preferred radio station in the poultry + SBCC district other than Radio Rwanda. We attempted to increase the likelihood that participants heard the radio campaign by sending text message reminders noting the content and times of the radio spots. However, less than half of respondents reported receiving text messages.

It is very likely that we could have vastly increased the reach of the radio campaign if we had worked with Radio Rwanda; however, because Radio Rwanda has a national reach, this would have impeded the ability to establish any credible counterfactual. The unfortunate downside is that radio listenership was greatly limited.

About 71% of respondents had a poster hanging in their homes. I had anticipated that poster distribution would occur during regular meetings between farmer groups and

field officers. However, due to COVID these meetings were disbanded, and field officers instead strove to meet each participant separately in their homes. Not all field officers managed to complete this task due to competing priorities, such as collection of payment on loans and enrollment of farmers in the subsequent season.

Finally, the in-person training did not happen as planned. Again, due to COVID-19, group trainings could not occur during the study period. Instead, One Acre Fund trained the 59 field officers in the poultry + SBCC district mainly through a train-the-trainers approach, in which a central health specialist trained the field director, who then provided virtual training to the field officers in small groups. The field officers were supplied with talking points and picture books for training (see Appendix C) as well as a list of chicken adopters who had children under five and instructed them to conduct one-on-one training as part of poster distribution. However, this task was one of many One Acre Fund field officers had among their overall duties, which included collecting repayment on One Acre Fund agricultural loans and other agricultural training. Therefore, adherence among field officers was very poor, and only 40.5% of respondents reported receiving any training at all (See Table 6.5).

The relatively minimal overall exposure to the SBCC, through radio, posters, text messages and in-person training, means that any impact I find should be considered a floor of potential impact rather than a result of a fully implemented program.

Figure 6.3: Radio listener frequency throughout the SBCC

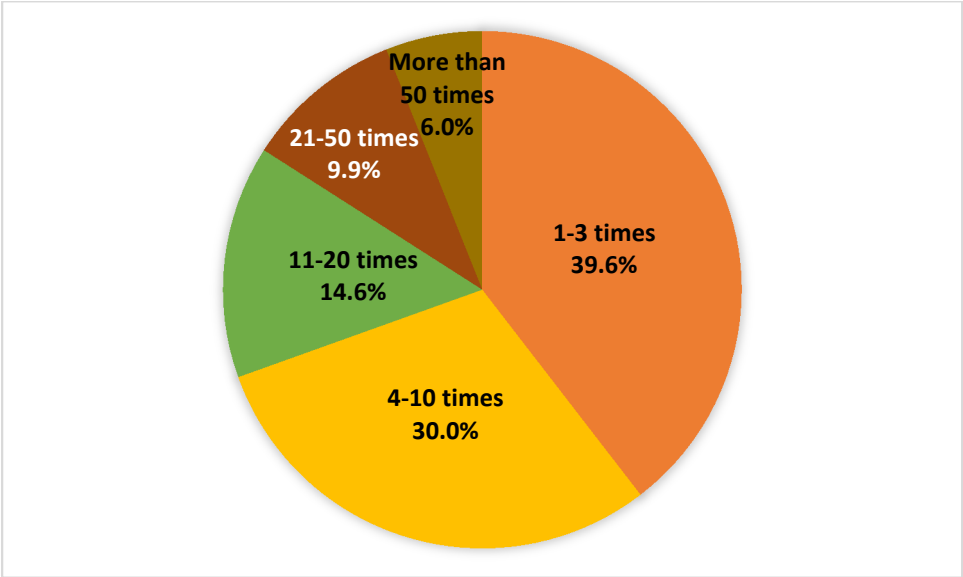


Table 6.5: Exposure to SBCC

Sample	746
Poster is still hanging	71.6%
Heard radio campaign	48.8%
Shared information from radio campaign (if heard radio spot)	51.1%
Received an SMS	42.0%
If received SMS, average number received	5.88
Attended a field officer training	40.5%

Results

As noted in the methods section, during the endline data collection, I discovered that the district of Nyabihu, which was selected to serve as a pure comparison area, held two campaigns encouraging more egg consumption by children and distributing eggs and chickens to families with young children. Therefore, I essentially do not have a "pure"

comparison area with which to test our theory of change and refer to this study arm as the "compromised comparison group." For transparency's sake, I will present the trend and outcome data from Nyabihu, but the interpretation of the analysis will account for this fundamental challenge in study design.

Unadjusted Trend data

I first present the unadjusted summary statistics. Because this is a difference-in-difference study design it is important to be transparent about the trends I observe in each district/ treatment group before conducting analyses.

Trends in Knowledge and Perceived Ability

The first link in our theory of change is that knowledge and attitudes around egg consumption will change for those exposed to the social behavior change campaign, so I investigate these trends first. As noted above, knowledge at baseline was already quite good with most respondents agreeing that eggs were good for overall health and brain development, so we might not expect dramatic improvements in these areas. However, it is possible that the SBCC might increase the level of enthusiasm in the original responses (e.g., from "agree" to "strongly agree"). The data presented in Table 6.6 are the *differences* in the percent of respondents who agree with the various statements between baseline and endline For example, in the poultry + SBCC arm 26% of respondents went from *not* strongly agreeing to strongly agreeing with the first statement that "eggs improve the health of young children." Overall, I observe a positive trend in *knowledge* in the poultry + SBCC arm), as well as in the compromised comparison arm, but only small changes in the poultry-only arm. Interestingly, the percent of respondents agreeing

with positive statements about their confidence in feeding eggs to children improved over every single district, despite the absence of a behavior change campaign in the poultry-only arm.

Table 6.6: Change in reported knowledge and attitudes, by study arm

	Treatment arm summary statistics		
	SBCC+ Poultry	Poultry	Compromised Comparison
Sample	*769*	*750*	*780*
Knowledge			
Change in % who strongly agree that feeding eggs improve health of young kids"	25.9%	6.4%	18.5%
Change in % who strongly agree that eggs improve brain development	22.8%	4.0%	18.7%
Change in % who strongly agree that feeding eggs to children is a "good investment"	32.6%	2.1%	18.1%
Change in % who disagree / strongly disagree that too many eggs are bad for children	15.2%	18.8%	20.6%
Perceived ability			
Change in % who agree or strongly agree that they are confident in reserving eggs for their children	27.4%	28.1%	49.7%
Change in % who agree or strongly agree that they are confident in buying eggs for their children	29.0%	25.5%	35.9%
Change in % who agree or strongly agree that they are confident in feeding eggs to their children 2 times per week	23.0%	19.2%	31.3%

When I compare the changes in each arm with one another, I observe small, but statistically meaningful, improvements in the poultry + SBCC arm relative to the compromised comparison arm in knowledge of egg benefits, but the compromised comparison arm outperformed the poultry + SBCC arm in terms of attitudes (See Table 6.7). The delivery of free chickens and eggs in the compromised comparison area may have increased respondents' ability to feed eggs to children, even if it did not increase knowledge at the same rate as for those respondents in the poultry + SBCC arm. The poultry + SBCC arm had even more dramatic changes in knowledge relative to the

poultry-only arm, but these did not translate into real changes in perceived ability. Finally, the poultry-only arm was outperformed by the compromised comparison arm in both knowledge and perceived ability.

Table 6.7: OLS Regression results for knowledge and attitude changes

	Poultry + SBCC (vs. Compromised Comparison)		Poultry + SBCC (vs. Poultry)		Poultry (vs. Compromised comparison)	
Knowledge	Change	p-value	Change	p-value	Change	p-value
Change in % who strongly agree that feeding eggs improve health of young kids"	6.1%	0.008	18.2%	0.000	-11.0%	0.000
Change in % who strongly agree that eggs improve brain development	4.3%	0.058	19.6%	0.000	-14.4%	0.000
Change in % who strongly agree that feeding eggs to children is a "good investment"	14.9%	0.000	32.2%	0.000	-16.4%	0.000
Change in % who disagree / strongly disagree that too many eggs are bad for children	-4.4%	0.038	-3.1%	0.150	-1.7%	0.441
Perceived ability						
Change in % who agree or strongly agree that they are confident in reserving eggs for their children	-23.5%	0.000	-0.8%	0.775	-22.7%	0.000
Change in % who agree or strongly agree that they are confident in buying eggs for their children	-6.7%	0.010	2.7%	0.300	-10.3%	0.000
Change in % who agree or strongly agree that they are confident in feeding eggs to their children 2 times per week	-8.8%	0.000	3.9%	0.111	-11.7%	0.000
** OLS Regression controlling for gender, marital status, number of cows, education, age, wealth status, household size*						

Behavior Change

The primary behavior change of interest was self-reported increase in egg consumption per week among children between 6 months and five years of age. Questions about egg consumption frequency were asked early in the survey, and amid a full food frequency survey module so as to obscure the focus on egg consumption alone and minimize social desirability bias. Because egg feeding behavior was quite rare (e.g.,

the median egg consumption was zero across all districts both at baseline and endline), I also estimated the percent of respondents who *increased* their egg consumption from baseline to endline. Overall, I found fairly low rates of egg consumption remaining at endline (See Table *6.8*). However, I found positive trends in the SBCC + poultry district (+ .182, p=.010) and the compromised comparison district (increase of + .236, p=.000), and a negative trend in the poultry-only district (-.109, p=.072).

Table 6.8: Reported egg feeding, past 7 days

	Poultry + SBCC	Poultry-only	Compromised Comparison
Baseline	0.697	0.653	0.263
Endline	0.876	0.549	0.502
Change	**0.179**	**-0.104**	**0.239**
Paired t-test	**.0104**	**.085**	**.000**

Explanation of unexpected findings

As noted above, we believe the improvement in egg consumption in the compromised comparison area was due to the existence of egg promotion programs in that area. However, the reduction in egg consumption among the poultry arm is unexpected. To understand that trend, I examined the overall trend in food consumption over the time period (see Table 6.9). I found an overall reported reduction in food consumption of nearly all food groups for young children in the time period. Among the food categories recalled from the past 3 days, ten out of the twelve meaningful food group changes were going in a negative direction. Because the respondents are all subsistence farmers, this likely reflects a seasonal fluctuation, whereby the endline survey

was conducted during a leaner period, in which families were reducing the overall amount of food consumed. In addition, it is possible that the effects of COVID in restricting mobility, increasing sickness and reducing remittances, led to a reduction in food frequency over the study period. In fact, a survey conducted by One Acre Fund and International Livestock Research Institute over the study period in Rwanda found that majority of respondents reported severe (>50%) reductions in their agricultural incomes, and 75% of respondents reported reducing the amount of food consumed and the variety of food consumed (Hammond et al., 2022). The decline in egg consumption over this period in the poultry-only arm likely reflects this overall downward trend, and the poultry program did not appear to do anything to mitigate the overall food consumption decline among eggs.

Table 6.9: Change in reported food frequency (all study areas)

	Change in food frequency	t-test (paired), p-value
Porridge (3 days)	-0.646	0.00
Beans (3 days)	-0.788	0.00
Rice (3 days)	-0.159	0.00
Irish Potatoes (3 days)	1.165	0.00
Sweet potatoes (3 days)	-0.25	0.01
Bread (3 days)	-0.265	0.00
Fruit (3 days)	-0.514	0.00
Green vegetables (3 days)	-0.879	0.00
Meat (3 days)	0.008	0.60
Fish (3 days)	-0.175	0.01
Nut (3 days)	0.054	0.00
Cassava (3 days)	0.045	0.53
Banana (3 days)	-0.189	0.00
Maize (3 days)	-1.138	0.00
Meat (7 days)	0.007	0.86
Milk (7 days)	-0.514	0.00

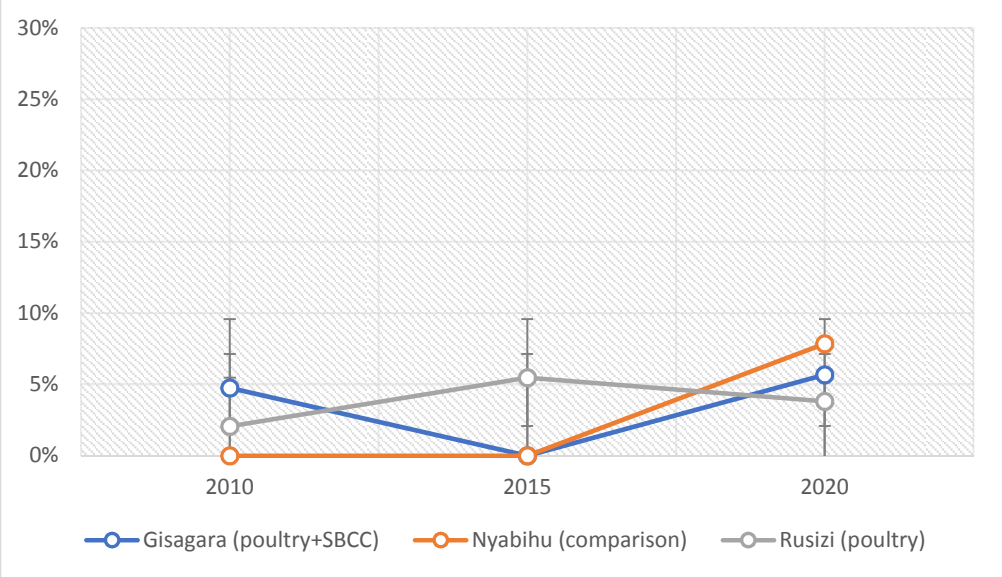
Adjusted Results for Behavior Change

The results on egg feeding behavior above simply represent a pre-post trend over time. However, in order to have a better causally identified estimate of impact, I make several adjustments. First, I present the difference-in-difference (DiD) estimates from the eggs consumed per week and the percent of respondents who reported increased egg consumption. The DiD estimate subtracts time trends from the group of interest by referencing a comparison group which we assume is on a similar trajectory. In this study, the reference comparison group was in Nyabihu, which I assumed would stand in as a reasonable counterfactual for the change in egg consumption over time that would have occurred absent the program intervention. However, as noted above, Nyabihu had a similar intervention, so does not operate as a good counterfactual. Still, I compare the poultry + SBCC with both the poultry-only and the compromised comparison group. I also compare the poultry-only with the compromised comparison group.

In addition, a main assumption of DiD is parallel trends, that each group would be on parallel trajectory absent the intervention. I do not have detailed annual data about the pre-existing trends in egg consumption. However, I was able to find some trend data from the Demographic and Health Surveys, which are national surveys that are conducted every five years. These data have several limitations that make them a bit less comparable to our data. First, the sample size at the district level is much lower (about 300 households per district per survey round). The data are also only collected every five years, and the data collection spans multiple months. For example, for the 2010 DHS round data were collected from September 2009 through March 2010, and, for the 2020 round, data were collected from November 2019 through June 2020. The smaller district-

level sample sizes and the wide duration of data collection, likely obscure annual trends, as well as the kind of seasonal trends we observe in the data. Finally, the data about egg feeding was not collected in the same manner. The DHS survey asked families about *whether* they fed eggs to children under five over the past 24 hours, whereas our survey asked respondents *how many* eggs they fed to children under 5 in the past 7 days. These data show a rather stable and low egg consumption over the last 10-year period (See Figure 6.4, which shows standard error of 1 in the error bars). It is difficult to ascertain any general trends given the large spacing of the data and the relatively small sample size, but there are no noticeable large trends, which surpass the error bars.

Figure 6.4: Percent of families who fed eggs to their children (<under 2 years old) in the past 24 hours

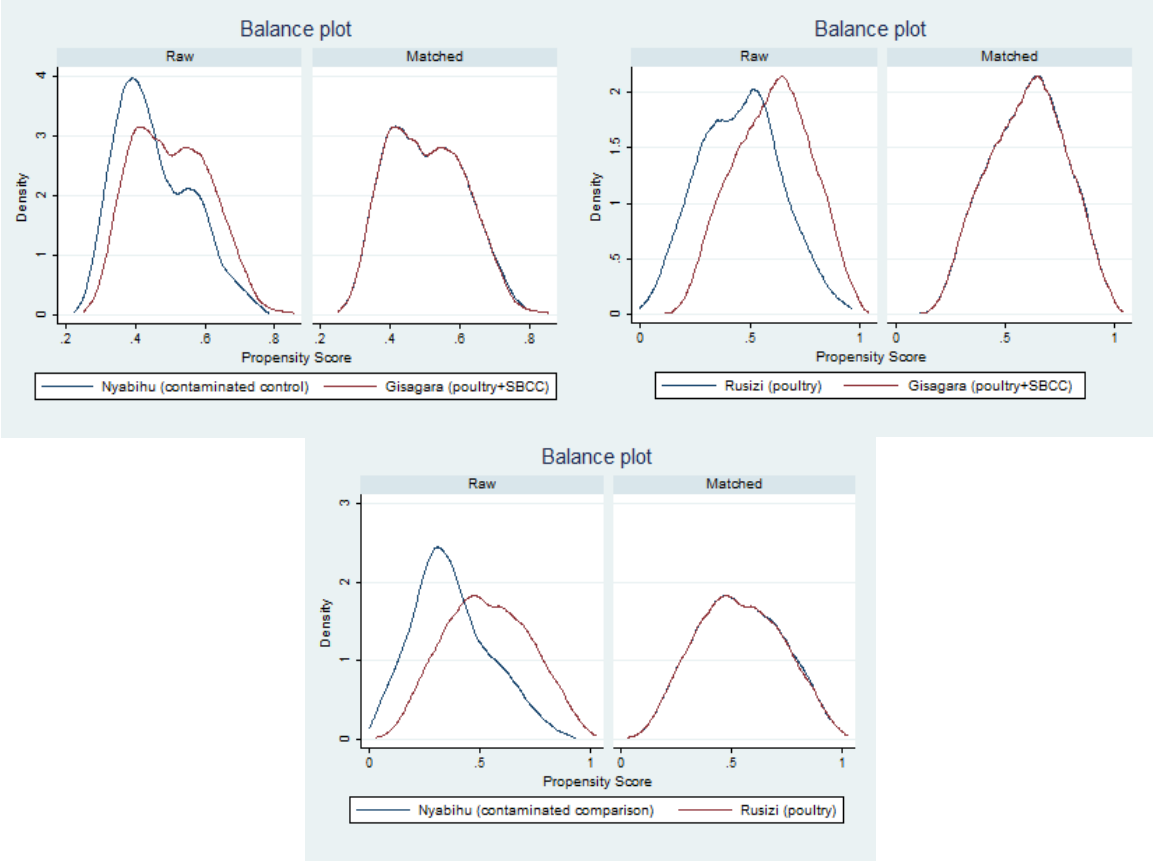


Source: Demographic Health Survey data

In addition to presenting the DiD estimates, I also present the DiD estimates adjusted with propensity score matching. I matched the treatment and comparison group in each analysis on gender, number of cows, land size, marital status, educational status, age of respondent, Ubudehe status, household size, whether the household had a phone

and the age of the child, all of which had differences at baseline between the groups and/or I had reason to believe would affect the outcome and were unlikely to be affected by the treatment. For example, I found some meaningful differences at baseline in number of phones, number of cows and land size, all of which can be considered wealth proxies that correlate with egg consumption, so I included those covariates in the matching algorithm. I used a nearest neighbor matching strategy with replacement and had good common support (the overlap of the densities of propensity scores for both groups) from which to match (see Figure 6.5).

Figure 6.5: Propensity Score Matching distribution plots, matched and unmatched



Finally, I present the DiD adjusted analysis, both with propensity score as well as the social desirability bias index as defined by the Marlowe Crowne Short Form C, which estimates a social desirability score for each respondent and can be used to adjust for respondent bias (Reynolds, 1982; Vu et al., 2011). Because the primary outcome of interest is self-reported and the campaign was clearly making the case that feeding eggs to children is a desirable activity, it was important to attempt to control for any social desirability bias. While I found that the M-C SDS was not an ideal scale to measure social desirability in this context, I include it as a control for completeness sake. A further discussion of this instrument and index is in Chapter 5.

All of these estimates are presented below drawing on the following comparison: I compare the poultry + SBCC group with the compromised comparison group, the poultry + SBCC with the poultry-only group and the poultry-only with the compromised comparison group.

Poultry + SBCC vs. Compromised Comparison

I had initially hypothesized that the biggest change in egg consumption would be between the poultry + SBCC group and the pure comparison group because the poultry + SBCC was addressing both access to eggs as well as motivation to feed children eggs. However, because the pure comparison district had a similar intervention and reported egg consumption increased in both districts, this hypothesis was unlikely to hold, and in fact did not. There were no significant impacts on average reported egg consumption overall, comparing the poultry + SBCC district with the comparison group, across all model specifications (See Table 6.10).

Table 6.10: Difference-in-difference estimates for poultry + SBCC vs. compromised comparison arms

	Unadjusted		**With propensity score matching**		**With PSM + controls for social desirability**	
Sample	1497		1379		1379	
	Coeff.	p-val	Coeff.	p-val	Coeff.	p-val
7 day recall (eggs)	-.064	.415	-.053	.669	-.123	.260
% increasing their child's egg consumption	0.64%	.766	4.25%	.148	-.1.46%	.614

Poultry + SBCC vs. Poultry-Only

I hypothesized that the poultry + SBCC would increase egg consumption relative to the arm with only poultry provided, since the formative research indicated that a key barrier was the perceived value of eggs. In fact, this is what I found. The poultry + SBCC intervention increased reported egg consumption by about .27 times per week (.276 times in the DiD estimate and .275 in the model which included propensity score matching and controls for social desirability bias), and this was robust across all model specifications (See Table 6.11). I also found that between 6% and 8% of respondents reported their child's egg consumption increased, and this was also robust across multiple model specifications. I consider this analysis the best estimate of the impact of the behavior change campaign because the pure comparison area was compromised.

Table 6.11:Difference-in-difference estimates for poultry + SBCC vs. poultry arms

	Unadjusted		**With propensity score matching**		**With PSM + controls for social desirability**	
Sample	*1426*		*1322*		*1322*	
	Coeff.	p-val	Coeff.	p-val	Coeff.	p-val
7 day recall (eggs)	.276	.002	.205	.079	.275	.020
% increasing their child's egg consumption	8.02%	.000	7.91%	.008	7.03%	.018

Poultry-Only vs. Compromised Comparison

I hypothesized that the poultry arm would either not outperform, or only slightly outperform, the comparison arm. However, because I know the comparison arm was compromised, this hypothesis is no longer appropriate. I present this analysis for transparency and completeness. As expected, the poultry-only arm under-performed relative to the compromised comparison arm. Respondents in the poultry-only arm reported they *reduced* the number of times eggs were fed to children by about .35 times per week, across all specifications (See Table 6.12). I also found a reduction in the percent who reported they fed their children eggs (7.4%), but this difference went away when I added propensity score matching. I expect that the reduction in the poultry-only arm relative to the comparison arm is a combination of an egg promotion intervention in the comparison area, as well as an overall reduction in food consumption in the poultry-only area.

Table 6.12:Difference-in-difference estimates for poultry-only vs. compromised comparison arms

	Unadjusted (DiD)		**DiD With propensity score matching**		**DID with PSM + controls for social desirability**	
Sample	*1441*		*1335*		*1335*	
	Coeff.	p-val	Coeff.	p-val	Coeff.	p-val
7 day recall (eggs)	-.341	.000	-.377	.004	-.348	.001
% increasing their child's egg consumption	-7.38%	.000	-4.17%	.208	-6.18%	.052

Treatment on the Treated

Given the relatively weak uptake of the SBCC intervention, it is also important to look at the impact of the program on those who actually received it. This is challenging because the SBCC program is multifaceted and prone to spillovers. Any given participant could have received any combination of direct training, exposure to the radio spots, text message reminders and receiving and hanging a poster. In addition, over half of those who heard the radio campaign (51%) reported discussing it with their friends and neighbors. So, there is no clear delineation of those who were treated and those who were not. Even so, we can investigate the trends among those who had various levels of exposure to the behavior change campaign. As seen in Table 6.13, I find that those with program exposure reported they increased their children's egg consumption more than those who did not for every level of program exposure; however, none of these differences had low p-values.

Table 6.13: Increase in egg consumption per week, by various levels of SBCC exposure

	Yes	No	p-value
Heard the radio campaign, have a poster hanging and attended a training	.259	.174	.696
Heard the radio campaign ***or*** have a poster hanging and ***or*** attended a training	.198	.143	.733
Heard the radio campaign	.227	.144	.156
Have a poster hanging	.220	.157	.664
Attended a training	.195	.183	.938

Estimates determined by OLS regression controlling for gender of respondent, marital status, number of cows owned, education, age, wealth status, and household size. OLS was appropriate here as the data were normally distributed. Yes / No estimates are marginal effects for those in and out of each subgroup. The full regression model output is in Appendix E.

Heterogeneous Effects

In addition to estimating the average impacts, it is important to understand if there are subgroups who are particularly likely or unlikely to benefit from the interventions.

Because the poultry intervention did not prove impactful, I focused mainly on the poultry + SBCC intervention and used the poultry arm as the counterfactual. I hypothesized that the impacts could differ by the wealth status, because those who are wealthier are more likely to be able to act on the message of encouragement and feed their children eggs. I created a wealth index using principal components analysis, which included assets, land size, ubudehe status and education, and created a binary wealth variable cut at the median of this index.

I also hypothesized that the behavior change campaign might be more effective for those who were already feeding some eggs to their children at baseline. This expectation was because I suspected that it is easier to convince families to increase the level of egg consumption among those who were already feeding eggs, rather than convincing families to undertake an entirely new activity. Thirdly, I wanted to see if impacts could differ by education level. Those with higher education might be better prepared to absorb information from training (both in-person and radio messages); however, it is also possible that those with lower education level might get a greater impact as they might have lower baseline levels of knowledge. Finally, I was interested to see if the intervention was differentially effective for children depending on their gender.

In Table 6.14 below, I present the results of the difference-in-difference analysis for each subgroup. I did not attempt any propensity score matching due to the reduced sample size for this subgroup analysis. I find that the poultry + SBCC program was impactful (relative to the poultry-only program) for all groups except for girls, those who were wealthier, and those who were more educated. However, the more educated constituted only 17% of the sample, and so this analysis was likely under-powered to

detect a meaningful effect. The largest differences were between girls (.138 increase in egg feeding per week, p=.255) and boys (.417 increase in egg feeding per week, p=.002). In addition, the program appears to have been more impactful for those who were already feeding eggs to their children at baseline (.629 increase in egg feeding per week, p=.004) than those who were not engaging in those practices at baseline (.256 increase in egg feeding per week, p=.002).

In order to see if any of the differences in impact between subgroups were statistically meaningful, I ran regressions including an interaction term between treatment and subgroup status. In this analysis, none of the interaction terms were significant.

Table 6.14: Results of DiD analysis (poultry + SBCC vs. poultry) for various subgroups

	Sample	**Impact on eggs per week**	**P-value**
Wealth			
High wealth status	*669*	.224	.112
Low wealth status	*662*	.312	.011
Already feeding eggs at baseline			
Egg feeder at baseline	*395*	.629	.004
Non-egg feeder at baseline	*1037*	.256	.002
Education			
Some secondary education	*265*	.313	.184
No secondary education	*1167*	.272	.005
Gender of child			
Boy child	*717*	.417	.255
Girl child	*715*	.138	.002
Gender of the caregiver			
Female caregiver	*1064*	.221	.049
Male caregiver	*486*	.297	.034

Chapter 7: Conclusions and recommendations

In this chapter, I summarize the findings from both the impact evaluation of the egg promotion campaigns as well as the assessment of the Marlow-Crowne Social Desirability Scale Short Form-C. I then discuss the implications of these findings for both practice as well as methods. I conclude with some comments on the limitations of this study.

Findings in Context

Market-based solutions to social problems in international development have been in ascendance in the past decades, with a greater reliance on micro-financing, micro-savings and private-public partnerships (Thorpe et al., 2017). The underlying logic is that rather than relying on national governments whose coffers are thin and institutional capacity often hobbled, or relying on capricious and uncertain foreign aid, market solutions offer a more sustainable and scalable option for addressing seemingly intractable problems. The key to success is to address market constraints or otherwise grease the wheels of the private sector in the short run and then the markets can unleash a more enduring social change. The nutrition sector, in particular, has seen an increasing awareness of the importance of private sector investments to ensure food systems serve all consumers and nutrition supplements are developed and effectively marketed to those who need it most (Nelson, 2006; Cordaro, 2013).

The poultry-only arm in this study, in a large degree, was a test of this theory applied to increasing egg production and consumption. Rather than giving away free chickens or eggs, which is expensive and unlikely to scale to meet the large gap in egg

consumption, the poultry-only arm addressed the problems of credit constraints and lack of supply. The One Acre Fund program provided families access to credit as well as a ready supply of chickens, which were bred to thrive in rural conditions and thus to be more profitable. Families in Rwanda were already somewhat sensitized to the importance of egg consumption by young children through previous campaigns. During the formative qualitative research for this study, most respondents were able to cite at least some health benefits of feeding eggs to children, and there were no countervailing myths about harms from feeding children eggs. The baseline survey also found that nearly all respondents in all three study arms agreed with statements asserting that eggs improve both health and brain development of young children. Therefore, if the only constraint to feeding young children more eggs was access to credit to purchase a ready supply of chickens, this arm should have been successful. However, this did not come to pass, and far from improving egg consumption, the poultry-only arm saw a small decline in egg consumption (-.104 eggs per week, p=.085) over the study period.

A decline in egg consumption coincided with a decline in the consumption of many food groups over the study period, which was likely driven by seasonal food supply changes that coincided with harvests. All of the families in this study were subsistence farmers, and dietary patterns fluctuate with harvests. In addition, we know that COVID-19 spiked in Rwanda over the study period, increasing travel restrictions, and ultimately reducing food consumption. So, the decline in egg consumption over this period in the poultry-only arm likely reflects this overall downward trend, and the poultry program did not appear to do anything to mitigate the overall food consumption decline among eggs.

We know from the formative research (Chapter 4), that while rural families understood the benefits of eggs for children's health and development, eggs were deemed too economically precious to consume within the household and were often sold. To quote one interviewee, "Most of those with chickens sell almost all eggs to help in solving other family issues which require money to be solved, such as in buying food, health issues and so on." Likely because the poultry-only arm did not have any encouragement to alter that perspective or significantly alter their access to eggs, we did not see any reported improvement in egg feeding in behavior.

The poultry + SBCC arm should have theoretically removed, or at least lessened, the barriers of financing, access, and motivation. The behavior change campaign was designed to address the main motivational barriers uncovered in the formative research by increasing the knowledge of perceived benefits relative to the costs. In particular, the messaging was designed to make the long-term promise of greater cognitive development and educational education (something parents highly prize) more salient. Messages repeated themes identified in the formative research as particularly important in child feeding practices, such as the promise of eggs as a superfood of nutrients, as a demonstration of love, and as an aspirational activity, all while acknowledging the very real challenges and trade-offs of engaging in that behavior change. The campaign also included regular reminders and cooking advice in order to make the behavior more practical and salient.

However, the SBCC campaign did not ultimately have a very high penetration. Listenership was low, with less than half of respondents ever hearing the radio campaign, and only half of those listeners reporting hearing it more than 4 times over the study.

Interaction with trained field officers was limited due to COVID-19, and poster distribution was also curtailed. So, only 41 percent reported attending a field officer training and only 72 percent had a poster hanging in their home. Therefore, the results can be considered a lower bound for a what a fully administered behavior change campaign might achieve.

Compared to the poultry-only arm, families in the poultry + SBCC arm reported increasing their child's egg consumption by about .275 times per week, according to the most robust specification, which was a difference-in-difference estimate with propensity score matching and controls for social desirability. Unfortunately, I was not able to isolate which components of the campaign were most effective, because the SBCC program was multifaceted and prone to spillovers. Any given participant could have received any combination of direct training, exposure to the radio spots, text message reminders and receiving and hanging a poster, and we found that many of those who received messages, discussed them with their friends and neighbors. I did find that those with more program exposure showed a larger change in reported egg feeding. However, I was unable to isolate which program components were the biggest drivers of these behaviors.

I found that knowledge of egg feeding benefits in the poultry + SBCC group increased relative to the poultry-only group. However, there was no increase in perceived ability to feed eggs to children. Some respondents reported in the endline survey that their chickens did not survive or that the chickens had not started laying eggs. Still others cited challenges raising chickens and the continued expense of eggs at the marketplace. Interestingly, both knowledge and perceived ability to feed their children

eggs increased for the compromised comparison group compared to poultry-only. Possibly these increases were because some respondents in that group received both an education campaign as well as a direct hand-out of eggs and chickens, which had more immediate impacts on perceived ability to feed children.

Implications for Practice

I found interesting differences in the impact of the poultry + SBCC compared to the poultry-only group among sub-groups. Notably, the SBCC campaign appeared to have no statistically meaningful effect on girls, but increased the egg consumption of boys by about ½ an egg feeding per week ($p=.002$). While the campaign included imagery of girls being fed eggs, and girls were featured in the radio spots, there was no explicit message to encourage egg feeding equally among children, regardless of gender. Prior data, collected by One Acre Fund, showed that there were no differences in overall dietary diversity by the gender of the child, and other research has found that girls are less likely to be stunted than boys in Rwanda (Nshimyiryo et al., 2019). Therefore, encouraging the feeding of eggs to girls was not made an explicit component of the campaign. It is possible that feeding habits of more common foods are not gender differentiated, but for more precious/ expensive food, boys are prioritized. This could be due to a general preference for investing in boys because they will be the ones to stay with their birth families as adults, or because boys are more likely to be stunted than girls in Rwanda. In order to reduce this potential disparity, future campaigns should encourage caregivers to feed girls, as well as boys, and should feature girls more prominently in all materials (Gillespie & vanden Bold, 2017).

In addition, I found that the program had a much larger impact on those who were already feeding eggs at baseline. Those who were already feeding their children eggs at baseline reported that they increased their child's egg consumption by .629 time per week (p=.004), whereas those who were not feeding eggs at baseline only increased egg consumption by .256 times per week (p=.002), relative to the poultry-only arm. It seems that the campaign's messages were more resonant with those who were already engaging in the behavior, and it was tougher to convince caregivers to adopt a wholly new behavior than it was to convince those who had already adopted the behavior to increase its frequency.

In some sense, we would have liked to have seen the opposite. Because eggs are expensive and consumption of eggs can be considered a proxy of wealth, it is more likely that the non-egg feeders were poorer. Non-egg-feeders likely had greater malnutrition and greater need for increasing consumption of eggs. So, we might have preferred this trend to be reversed, so that there was greater impact of the campaign on those who most needed it most. However, knowing that the campaign was most effective with those who were already feeding their children eggs, it could make sense to target that group.

The overall increases in egg consumption were rather low, and unlikely to make a significant impact on the nutritional status of children; however, these increases are something that future campaigns can build on. The hallmark study that found a dramatic reduction in stunting and prompted enthusiasm for promoting egg feeding, delivered eggs daily and increased egg consumption to 7 eggs per week (Iannotti et al., 2017). Other studies that found impacts on linear growth or undernourishment also had associated egg consumption of between at least 4-5 eggs per week (McKune et al., 2020; Omer, et al.,

2018; Baum et al., 2017). Some studies with much lower egg consumption did find impacts on nutritional outcomes, but these studies generally had more holistic interventions, such as home gardens or income generating activities (Passarelli et al., 2020; Larsen & Lilleor, 2017). However, even if lower egg consumption increases do not generally improve linear growth, there could be other more subtle benefits. A study in Thailand which found that an additional 3 eggs per week among school children increased levels of Albumin, PreAlbumin and HDL levels, which are important for correcting protein malnutrition (Mayurasakorn et al., 2013).

The average reported increases in egg feeding in this study are unlikely to meaningfully affect the nutritional status of children in the sample. Still, the fact that I observed some reported increases in egg consumption despite low penetration of the behavior change campaign indicates that a campaign with deeper penetration into the community, such as more in-person interactions and a radio campaign on the highly listened to national radio could have even a greater impact.

The impacts of the poultry + SBCC arm discussed above were all relative to the poultry arm, so should be considered impacts of the behavior change campaign alone. We had initially intended to estimate the impacts of each component (poultry and SBCC) by including 3 arms, poultry + SBCC, poultry-only and a pure comparison, the latter of which was to serve as a pure counterfactual. However, as noted earlier, I discovered late in the span of the intervention that the comparison district had initiated an egg and chicken distribution campaign, and thus could no longer be considered a pure comparison arm. Therefore, even though egg consumption declined in the poultry-only arm, I cannot say for certain that the poultry-only campaign had no impact. It is theoretically possible

that egg consumption would have declined more precipitously in a comparison area that had no poultry program. The lack of a pure counterfactual means we cannot effectively evaluate the true impact of the poultry component or the poultry + SBCC combined arm. However, the overall decline in egg consumption in this poultry arm is not encouraging.

Conclusions for Methods

The most glaring challenge for this study was the contamination of the pure comparison area, which effectively eliminated it as a counterfactual to evaluate either of the other arms. This is a large risk of running a study in which each arm covers one contiguous region rather than multiple (ideally randomized) clusters. However, because a main component of the SBCC was a community radio campaign that covered a large region of Rwanda, I was unable to randomize across smaller geographic areas and include multiple clusters of each arm. Having only a handful of geographic areas from which to assess a particular radio campaign is a common problem among evaluation of radio campaigns. Recent studies in Ghana and Mexico evaluated the impact of nutritional messages on child feeding behavior using a similar design of difference-in-difference, and each included only one treatment and one comparison area (Saaka et al. 2021; Monterrosa et al. 2013). In larger countries, like the US and India with multiple radio markets, researchers have been able to run well powered clustered randomized trials (> 60 clusters) to assess the impact of various radio campaigns (de Rooij & Green, 2017; Schechter & Vasudevan, 2021). However, this was simply not possible in Rwanda, a country the size of the state of Maryland.

It might have been possible to circumnavigate the problem of small number of clusters by convening and randomizing small groups to which researchers could play

radio messages. However, this method would have had poorer external validity, as it does not adequately represent a radio campaign which is played multiple times per day and listened to often in the background of daily activities. So, I employed a riskier strategy with respect to internal validity, to preference external validity. This risk was certainly manifest, as our only comparison arm had to be eliminated due to having multiple similar programs implemented over our study period. I had initially attempted to mitigate this risk by inquiring across multiple districts which districts has any competitor programs. At that time, the projects in question were running in those areas, but had not yet instituted an egg promotion campaign. If I had had more time and resources, it would certainly have behooved us to do a more thorough investigation of all health, nutrition and agriculture programs running in each potential comparison areas, and this is obviously recommended for any future studies which employ a similar design.

Social Desirability Bias

Another key challenge in evaluating a behavior change campaign is in the reliance on self-reported data. Where it is not possible to collect data on physical or biometric outcomes, we must rely on respondent's self-reports, which can be subject to a number of reporting biases, notably social desirability bias, in which the respondent attempts to present his/herself in the most socially favorable light. In this study I took several steps to ensure that respondents reported their child's egg consumption truthfully. First, when asking for consent to be surveyed, enumerators noted that the study was looking at nutrition outcomes more broadly rather than egg consumption specifically. Enumerators also asked about egg consumption amid food feeding modules of multiple other

categories of food. Finally, the survey included a measure of social desirability bias, the Marlowe-Crown Social Desirability Scale, Short Form C (M-C SDS).

While it was initially developed in the US among university respondents, the M-C SDS has been modified to a shorter scale and has been used increasingly across the globe to test and control for social desirability bias. I found over a dozen studies conducted since 2007 in Africa that reported SDB scores, assessed the validity of the instrument and/or used the SDB scores to control for bias. Despite some of these studies having a rather low reliability (alpha<.6), most concluded that the M-C scale useful for assessing this bias in African samples or implicitly concluded so by using the measurement in their analyses.

This study found that the M-C SDS was inadequate for measuring and controlling for social desirability among rural Rwandan respondents. The reliability was much lower than what has been previously found, and this reliability was low across multiple rounds of administering the survey (<.4 in both rounds). In addition, there was almost no correlation at all between SDB scores and the outcome of interest, which was hypothesized to be affected by SDB. Finally, while the average M-C SDS scores were identical across survey rounds, the Pearson's correlations coefficient of scores at the individual level was very low (.351), another indication that the scale was not adequately reliable.

Previous studies have found multiple underlying constructs in the M-C SDS, but there has not been a lot of consistency among surveys. Verardi and co-authors found two constructs related to achievement and interpersonal relationships, Ramanaiah found constructs related to attribution and denial, and Paulhus found constructs related to self-

deceptive enhancement and image management (Verardi et al., 2010; Ramanaiah et al., 1977; Paulhus, 1984). While these findings are confounding and slightly contradictory, they at least all relate conceptually to social desirability bias. The exploratory factor analysis uncovered five distinct factors, which were the same across both survey rounds, but none of which appeared to be related to concepts uniquely associated with social desirability.

Altogether, these results suggest that the M-C SDS is a poor way to measure and control for social desirability bias, at least in rural Rwandan populations. These results are somewhat out of sync with what others have found in African samples, who have generally found higher reliability and fewer underlying constructs (see Chapter 5 Table 5.2). However, those studies generally relied on younger, more urban and more educated respondents, for whom the scale may be more suited.

There is increasing interest in measuring and controlling for response biases in order to more valid estimated outcomes, particularly in international development research, which has exploded in recent years (Cameron et al., 2016). Unfortunately, there are only a few instruments available to measure social desirability bias. The M-C SDS Short Form 3, is an alluring choice, since it only contains 13 statements and has been previously used in African samples. However, one cannot escape the fact that Short Form C is over 35 years old and (and the original scale is over 60 years old) was developed in a vastly different cultural context. A large body of research supports the idea that collectivist societies exhibit more social desirability and particularly around the denial of socially undesirable traits. (Johnson and van de Vijver, 2003; Bernadi, 2006; Van Hemert

et al., 2002; Lalwani et al., 2006). It is therefore high time that instruments be developed, that are more tailored to non-Western cultural contexts.

Limitations

There are several limitations to the conclusions reached in this study. As noted above, the social behavior change campaign was not implemented at the ideal scale that would have reached a higher percentage of intended recipients or at the intensity likely to prompt significant behavior change. Therefore, it is unsurprising that the impacts we found were quite small. In addition, it is also possible that a longer campaign would yield different results. Six months is not a long time to affect a change of norms of behavior, particularly when it comes to sticky preferences like food or entails a perceived or real sacrifice. A recent study of a radio campaign in Burkina Faso encouraging behaviors associated with child survival found changes in some care-seeking behaviors, but only after a full 20 months of the campaign (Sarrassat et al., 2015). So, it will be important, given the initial signs of early impact to continue this campaign and study effects after a longer duration.

In addition, given the weaknesses of the M-C SDS to adequately measure social desirability bias, I cannot rule out that some of the impact I found was due to that bias. However, the M-C SDS was wholly uncorrelated with the egg consumption metric which does provide some assurance that SDB was not influencing responses, even with a weak measurement of SDB. It is likely that given the low penetration of the SBCC, that social norms were not altered enough to induce respondents to inflate their answers. Still, I cannot rule out some influence of SDB.

The conclusions reached here are also potentially unique to the Rwandan context. Rwandans have a high radio listenership in general, and the society tends to be rather hierarchical with a strong deference to authority (Staub, 2014). Therefore, it is possible that behavior change campaigns will be more effective in Rwanda than in other places. The conclusions reached about the inappropriateness of the M-C SDS might also be unique to the rural Rwandan context.

Finally, while I strove for the most rigorous design possible given constraints, the difference-in-difference design and propensity score matching both rely on assumptions which were not wholly testable. For difference-in-difference estimates, we have to assume that egg consumption patterns were on parallel trends in all study areas. While the available data suggests that this was the case, the data are not fully comparable in terms of the frequency, target group, recall period and geography. So, it is not possible to fully satisfy this assumption. In addition, propensity score matching relies on the assumption that, conditional on some observable characteristics, untreated units can be compared to treated units, as if the treatment has been fully randomized. This is asking a lot of our observable characteristics, and I cannot rule out that there are some unobservable differences among the treatment groups.

Future studies should attempt to ensure either a higher penetration (for example, more frequent in person trainings, a higher radio listenership) or have a longer duration given how challenging it can be to change feeding behaviors. In addition, to avoid the problems associated with non-comparability of groups, researchers should attempt, where possible, to include a greater number of clusters for each arm, and to randomize where feasible. Also, where possible, confirmation of self-reports is essential through bio-

markers or other physical evidence, such as measures of linear growth. Where this is not possible, other techniques to control for social desirability, such as list randomization or employing a culturally specific psychometric tool to assess social desirability bias.

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Appendix A: Survey Instruments

Eggs baseline survey

1	Enumerator Name	
2	District	List
3	Site	List
4	Date	
5	Survey attempt	1, 2, 3
6	(Consent) Good morning. My name is (INSERT name). I work with the research department at Tubura. Today I am asking you to participate in a research study titled "Nutrition Promotion through Behavior Change." This study is being led by Kim Siegal at George Washington University and Tubura. The purpose of this study is to better understand how to improve Rwandan families' nutrition, especially among children. As part of this study I will ask you some questions today about your families eating habits today and will return in 6 months-time to ask you a similar set of questions. These questions should take about 45 minutes. We do not anticipate any risks from participating in this research. We do hope that the lessons from this research will benefit the larger community of smallholder farmers by learning about how to best improve feeding practices for young children. You will not receive any compensation for this study and any answers you provide here will not qualify you or disqualify you from any program. We will not share any personally identifying information with anyone else. Only the research team will have access to the full data. De-identified data, (that is your responses, but not anything that can link them back to you) may be shared with the research community at large to advance science and health. We will remove or code any personal information that could identify you before files are shared with other researchers to ensure that, by current scientific standards and known methods, no one will be able to identify you from the information we share. Despite these measures, we cannot guarantee anonymity of your personal data. Taking part in this study is voluntary and you may refuse today or discontinue at any time. You may also feel free to not answer any questions which make you feel uncomfortable. Do you consent to participate in this study?	1. Yes 2. No (thank them for their time and discontinue the survey)
7	What is your name?	
8	Is your household raising chickens currently?	1. Yes 2. No (discontinue the survey)
9	Does your household have any children ages 5 or under	1. Yes 2. No (discontinue the survey)

10	Are you the primary caregiver of the youngest children in the household? *("Primary caregiver" is the parent or guardian who has the main responsibility for the daily care and raising of a child.)*	1. Yes (continue) 2. No (move to find the primary caregiver in the household to conduct the survey with them)
11	Gender of respondent	1. Male 2. Female
12	Age of respondent	
13	How many members are in your household? (we define a household as those who share a meal at least 5 times per week. You can also include dependents at boarding school)	
14	What is your marital status?	1. Married 2. Divorced/separated 3. Widowed 4. Single
15	Please list all children 5 years and under (their names and ages	Child 1: (name____ age___) Child 2: (name____ age___) Child 3: (name____ age___) Child 4: (name____ age___)
	I would now like to ask you about some questions about the diet of the youngest child in the household, who is 5 years old or younger but who is older than 6 months old. Can you tell me the name of this child?? (CHILD'S NAME)	
	FAO Individual Dietary Diversity Module (Q16-Q33) Now I would like to ask you to tell me about the foods and drinks that (CHILD'S NAME) consumed yesterday during the day or night whether [CHILD'S NAME] ate it at home or elsewhere. Please include all foods or drinks, any snacks or small meals, as well as any main meals. (Enumerator will first get the respondent to list out all meals and snacks eaten over the full day and then check with the farmer to make sure that foods in each food group are represented) ***Note: The full list of foods in each category will be refined in survey pilot***	
16	When was this child born?	Month___ Year_____
17	What is this child's gender	1. Male 2. Female
18	CEREALS; Porridge, bread, rice, noodles, or other foods made from grains (e.g. ugali or githeri)	1. Yes 2. No 3. Don't know
19	VITAMIN A RICH VEGETABLES AND TUBERS; Red, orange or yellow vegetables that have yellow or orange flesh (carrots, squash, orange fleshed sweet potatoes, pumpkin)	1. Yes 2. No 3. Don't know
20	WHITE ROOTS AND TUBERS; White potatoes, white yams, cassava, or any other foods made from roots, tubers or plantain (e.g. matoke)?	1. Yes 2. No

		3. Don't know
21	DARK GREEN LEAFY VEGETABLES; Kale, cassava leaves, pumpkin leaves (seveve), Jutt Mallow (mrenda), nderema, bean plant leaves, Suja, cowpea leaves (Kunde), Miro, Spider plant (Saga), amaranth leaves (Dodo/Terere)	1. Yes 2. No 3. Don't know
22	VITAMIN A RICH FRUITS; Red, orange or yellow fruits (mangoes, papaya, melon) and 100% fruit juices made from these fruits	1. Yes 2. No 3. Don't know
23	OTHER FRUITS OR VEGETABLES; Any other fruits (coconut, apple, 100% fruit juices) and vegetables (Eggplant, avocado, zucchini, cucumber)	1. Yes 2. No 3. Don't know
24	ORGAN MEAT; Liver, kidney, heart, or other organ meats or blood-based foods	1. Yes 2. No 3. Don't know
25	FLESH MEATS; Any meat, such as beef, pork, lamb, goat, chicken, or duck	1. Yes 2. No 3. Don't know
26	EGGS; Chicken, duck, guinea fowl or any other egg	1. Yes 2. No 3. Don't know
27	FISH; Fresh or dried fish, shellfish or other seafood?	1. Yes 2. No 3. Don't know
28	LEGUMES, NUTS AND SEEDS; beans, peas, lentils, nuts, seeds or foods made from these	1. Yes 2. No 3. Don't know
29	MILK AND MILK PRODUCTS; milk, cheese, yogurt or other milk products	1. Yes 2. No 3. Don't know
30	OILS AND FATS; Any oil, fats, or butter, or foods made with any of these	1. Yes 2. No 3. Don't know
31	SWEETS; Sugar, honey, sweetened soda, sweetened juice or sugary foods such as chocolates, candies, cookies and cakes	1. Yes 2. No 3. Don't know
32	SPICES, CONDIMENTS, BEVERAGES; Black pepper, salt, soy sauce, hot sauce, coffee, tea et	1. Yes 2. No 3. Don't know
33	Grubs, snails, or insects (e.g. termites, grasshoppers, crickets)?	1. Yes 2. No 3. Don't know
34	How many times did the child eat meat over the last 2 week?	
35	How many eggs did the child consume over the past week?	
36	How many times did the child consume milk products over the past week?	
37	How many chickens do you currently have?	

38	How many of each type of chicken do you have?	Sasso_____ Village_____ Layer_____ Broiler_____ Don't know type_____
39	What is the main type of food your chickens eat? (choose 1)	1. Commercial feed 2. Scavenging 3. Family food scraps 4. Mix of the above 5. Other _____
40	Do your chickens produce any eggs?	1. Yes 2. No (go to next section)
41	About how many eggs does your flock produce each week ?	
42	In the past week, have you purchased any eggs to eat at home?	1. Yes (how many?_____) 2. No
	Now I am going to reach a number of statements. I will then ask you if you disagree strongly, disagree, agree, agree strongly or don't know. Some statements, like "I love going to church" you might feel very strongly about, so you would say "strongly agree". Some statements, like "this has been a good rainfall season" you might agree with but not strongly. The options will be "agree strongly", "agree," "disagree," "strongly disagree" or "don't know." Please consider each statement and then decide what you think.	
43	Raising chickens is difficult (*warm up question*)	1. Agree strongly 2. Agree 3. Disagree 4. Disagree strongly 5. Don't know
44	We need to sell all the EGGS we produce, so we have enough money for emergencies and other important expenses.	1. Agree strongly 2. Agree 3. Disagree 4. Disagree strongly 5. Don't know
45	I let my chickens scavenge during the day to produce eggs less expensively.	1. Agree strongly 2. Agree 3. Disagree

		4. Disagree strongly 5. Don't know
46	Men work the hardest and therefore should be eating EGGS, rather than children eating eggs.	1. Agree strongly 2. Agree 3. Disagree 4. Disagree strongly 5. Don't know
47	Eating EGGS regularly improves the health and brain development of young children.	1. Agree strongly 2. Agree 3. Disagree 4. Disagree strongly 5. Don't know
48	I am confident I can reserve some of the EGGS we produce so my young children can eat them.	1. Agree strongly 2. Agree 3. Disagree 4. Disagree strongly 5. Don't know
50	Feeding young children EGGS is a good investment that will improve their school performance when they start school.	1. Agree strongly 2. Agree 3. Disagree 4. Disagree strongly 5. Don't know
51	My spouse supports me in feeding my children eggs.	1. Agree strongly 2. Agree 3. Disagree 4. Disagree strongly 5. Don't know
52	I am confident I can feed my young children EGGS at least twice per week.	1. Agree strongly 2. Agree 3. Disagree 4. Disagree strongly 5. Don't know
59	How many cows does your household own?	
60	How much land does your household own (in ares)?	
61	What is the highest level of education you have achieved?	1. No formal education 2. Some primary school 3. Primary graduate 4. Some secondary 5. Secondary school graduate

		6. Some college/university 7. College/university graduate
	Marlow-Crowne Social Desirability Scale – Short Form C (Q62-74, only administered at baseline) Next I am going to ask some questions to get to know you your opinions a bit better. I will read out some statements and please just tell me whether each is true or false for you personally. Again, these responses will kept confidential, so please respond freely.	
62	It is sometimes hard for me to go on with my work if I am not encouraged	1. True 2. False
63	I sometimes feel resentful when I don't get my way	1. True 2. False
64	On a few occasions, I have given up doing something because I thought too little of my ability	1. True 2. False
65	There have been times when I felt like rebelling against people in authority even though I knew they were right	1. True 2. False
66	No matter who I'm talking to, I'm always a good listener.	1. True 2. False
67	There have been occasions when I took advantage of someone	1. True 2. False
68	I'm always willing to admit it when I make a mistake	1. True 2. False
69	I sometimes try to get even rather than forgive and forget	1. True 2. False
70	I am always courteous, even to people who are disagreeable	1. True 2. False
71	I have never been irked when people expressed ideas very different from my own	1. True 2. False
72	There have been times when I was quite jealous of the good fortune of others	1. True 2. False
73	I am sometimes irritated by people who ask favors of me	1. True 2. False
74	I have never deliberately said something that hurt someone's feelings	1. True 2. False
	Thank the respondent for their time in sharing their personal views.	
	Record GPS	

Endline survey

This survey will be the same as the survey above, but will be pre-populated with the location information and basic demographic information (name, age, education level, gender).

It will also exclude the social desirability module at the end as it does not need to be administered twice.

The endline survey will add these additional questions used to obtain information about respondents' experience with the programs.

1	Did you hear the radio campaign promoting egg consumption?	1. Yes 2. No (move to Q 5)
2	How many times did you hear the radio campaign promoting egg consumption over the past 6 months?	1. I did not hear the radio campaign 2. 1-5 times 3. 5-10 times 4. 10-20 times 5. More than 20 times 6. Do not remember.
3	Which characters in the radio campaign do you remember?	responses to be developed after the radio campaign is finalized
4	What story in the radio campaign do you most remember?	responses to be developed after the radio campaign is finalized
5	Did you or someone in your household attend a training from your Tubura field officer on how to raise chickens well?	1. Yes 2. No
6	Did you receive text message reminders from One Acre Fund about egg consumption?	1. Yes 2. No
7	*Enumerators: Is the nutrition poster still hanging in the respondent's household?*	1. Yes - it is visible 2. Yes - the respondent said it was visible but I did not verify 3. No
8	Enumerator: Ask this section only for respondents who had NOT attended the nutrition groups	

9	In the past 6 months, has a Tubura group leader ever spoken to you about feeding eggs to young children?	1. Yes 2. No (Skip to Q 12)
10	About how many times did you have a conversation with a Group Leader about feeding eggs to children in the past 6 months?	
11	Did the Group Leader share any visual materials with you about feeding eggs to children (e.g. such as poster or flip books)	
12	What messages do you remember from your conversations with group leaders?	1. Eggs promote growth 2. Eggs help brain development 3. Eggs are like a "super vitamin" 4. Eggs should be given to young children 5. Other _____
13	Did anyone else in your community discuss feeding eggs to children with you in the past 6 months? If so, who?	1. No one 2. Yes - CHW 3. Yes - FO 4. Yes - Church leader 5. Yes - neighbor 6. Yes - family member 7. Yes - other
14	About how many times did people other than the Group Leader discuss feeding eggs to children in the past 6 months?	
15	Did you start or increase feeding eggs to your children in the past 6 months?	1. Yes 2. No (skip to #)
16	For what reason did you start feeding eggs to your children / increase the eggs you feed to your children? (check all that apply)	1. I have more more egg production 2. I want my children to achieve high education 3. I want my children to grow 4. I want my children to be healthy 5. I want to please my community 6. I want to please my spouse 7. Other_____
17	What is challenging about feeding eggs to children?	1. Children do not like it

		2. My chickens do not produce enough eggs 3. Eggs can be sold for money for needed things 4. I don't have enough for all of my children 5. I prefer not to feed eggs to children 6. I prefer to feed children more filling foods than eggs 7. Other_____
	What other feedback do you have for Tubura poultry program?	
	Thank the respondent for their time and record GPS.	

Appendix B: Radio Campaign Concept and Spots

Spot 1: Nutrients found in eggs and their importance to a child's health (Nutritive Value of Eggs)

CHARACTERS:

Patirisiya *Woman*: Health Counselor. She was trained in nutrition. She understands the importance of eggs in a child's health. She is responsible for mobilizing the villagers to feed eggs to their children

Bwite *Mukandekezi's Husband *: He is a farmer. For him, there are no better nutrients than a child who eats and gets satisfied.

Mukandekezi * Bwite's wife *: She always wants her children to grow up mentally and physically, but her husband is a hindrance to her.

VENUE OF SKETCH:

At Bwite and Mukandekezi's house

Real Spot:

Bwite: Mukandeke, ... is this the food that you give to children when they come home for lunch?... Spending so much money on adding eggs to their meal. Is the other food not enough to stick in their stomach?

Mukandekezi: I added the eggs because it is full of nutrients to help the child in school. Yes, it is good that we give them food to fill their stomach, but we cannot only focus on just filling their stomach with just any food. They also need nutrients that can make them

grow up physically and mentally! Don't you see how healthy and smart Patrisiya's children are? I want our children to also be like that .....

Bwite: (Mocking tone) Ohhh! So you think it is because of eggs that Patrisiya has smart children?

Mukandekezi: Yes! Her children are doing well because of what they are gaining from the food they are eating. Didn't the ancestors say that "the strength comes out of what you have in the stomach"?

Patirisiya (At the gate greeting): Hello here!

Bwite: Open the gate for visitors, you will continue your food debate after they leave!

Mukandekezi: really.... Patricy, sorry I'm not ready yet. Please wait a little, I will quickly get my things before we go.

Bwite: Mukandeke you stay here first and tell her what made you late. Patricy, isn't Mukandeke your friend? She is giving eggs to my children when they come home for lunch! Is that really a wise use of money?

Patirisiya: But Bwite, I think I will have to support Mukandeke here. Eggs truly have many benefits especially for young children who are just growing and developing.

Mukandekezi: Tell him maybe he will listen to you as a health mobilizer!

Bwite: Of course you support her, isn't she your friend?

Patirisiya: (Laughing) It's not because she's my friend, but because what she is saying is correct. The truth is that Eggs have many nutrients that help your child mentally and physically. It even has a special nutrient that improves your child's memory, helping them remember things better, concentrate better in school, and understand things easier.

Mukandekezi: It's true! Even our neighbor Maria, she started adding eggs to her children's meals just last year, and already she has seen the benefits, her children are so much healthier and their teachers in school even say how much better their performance has gotten.

Bwite: Okay, you say it can help the child who is in school, but you are even giving eggs to the little one who has not started school yet!

Patrisy: Bwite this is even the best time for that small one to start eating eggs. As she is growing, what you feed her now is the foundation for how healthy she will be in the future.

Mukandekezi: Yes, at the last training Patrisy, you even told us that feeding eggs from very early can strengthen small children's bodies to fight against infections, and even helps them to have strong bones and a healthy body.

Patrisiya: Yes, we are really encouraging parents to feed their children eggs from a young age because it is really helpful. For example, sometimes when you see children that are always tired, or having dry skin and weak bones that they cannot even walk uphill - they might be lacking in nutrients that they could have easily gotten from eggs.

Bwite: This really sounds too good to be true. Can just eggs be so amazing to do all this?

Patirisiya: (Laughing) Bwite, these are only a few of the benefits. When you hear all of them you will always make sure your children have eggs to eat. Mukandeke has been attending the Tubura nutrition training, why don't you attend the next one with her?

Bwite: Patrisy, I will definitely attend to learn more about this

Patirisiya: Great! That's the attitude of a smart parent.... Even though it can be difficult to buy eggs or raise chickens for eggs, it is well worth the investment. Yes, eggs are precious, but your children are even more precious.
Mukandeke, quickly get ready so we can go and find the meeting when it is still going on.

If we can invest in fertilizer to help our plants grow, we should invest in our children to give them the best chance at a successful life.

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END!

Spot 2: People may think that there are other foods that can replace eggs (Egg Alternatives)

CHARACTERS:

Diregiteri: School headmaster

Bwite(Man): Parent 1

Namahoro(Woman): Parent 2

Manyurane: Parent 3

Patirisiya *Woman*: Health Counselor.

THE VENUE OF THE SKETCH:

At the school committee meeting of Parents

THE REAL SKETCH

(There is the noise of parents in the background….)

Diregiteri: First of all, let me thank you for attending. Among the main topics that I want us to discuss today is the school's concern about the children's nutrition. We have some students who often fall asleep in class, or miss class completely because of sickness. We are worried that they are not getting the right foods to fully support their development. I know that as parents, you are already doing your best to provide for the children, but I want to encourage all of you to especially try to include eggs in your children's diets… I see that someone has a question. Let's listen to him

Bwite: My name is **Bwite,** …I also have a child in this school. Mr Headmaster, I really agree with you that good nutrition is very important to the child. But, as you know in Rwanda we have many types of foods, why do you stress more on that egg?

Namahoro: My name is **Namahoro….** by supporting what my fellow parent said, if the child is eating and getting satisfied, then not eating eggs cannot prevent him from performing well at school….

Mwalimu: Let me answer both of you at once…. I totally understand that our number 1 goal as parents is making sure our children have enough food to eat. But then we must also make sure that we are filling their stomach with the right foods. Things that are high in nutrition. And that is why I mentioned eggs. Because even just a single egg has many exceptional nutrients that you cannot find together in other foods.
Good enough our health mobiliser Patrisiya is also here today so she can also add some knowledge…….
Patirisiya: Really what the headmaster is saying is very correct. And since we are talking about the children's performance in school, I think I should also tell you about the choline in eggs.
Namahoro: I've not heard of choline before. What exactly does it do for my child?
Patrisiya: When your child gets enough choline it improves their memory, helping them remember things better, concentrate better in school, and understand things easier. That nutrient is very important for the development of the brain from the time when the child is in their mother's stomach and even when they are born. And you can get over 20 times more choline in eggs than if you feed your child the same amount of boiled potatoes. So from childhood, even when they are still very little, you should already be feeding your children eggs if you want them to grow well and perform well in school.
Manyurane: My name is **Manyurane**… Patrisiya, I have always been feeding my

children sweet potatoes. It keeps them full and they like it too. Are you saying this is not

nutritious for my child?

Patrisiya: Not at all, sweet potatoes are OK, but they can't compare to eggs in terms of the amount of different nutrients your child can get from eggs. Sometimes, it can be difficult to get enough of these other foods to get the right amount of these nutrients for your children but just by adding two or three eggs per week, your child can easily get the nutrients they need for good physical and mental growth in the correct quantity.
Digiteri: It even helps you save money as you will need less food to get the full nutrients your child needs. In a way, you can even think of eggs as the foundation that you are using to build a healthy body for your children now and in the future.

Patrisiya: For example, Eggs have proteins which are 6 times more than what you can get when eating the same amount of boiled potatoes. These proteins can be considered as what builds up your child's body. Their muscles are made of proteins, and even the cells in their bodies that fight diseases are made of protein. Protein even helps your child stay full for longer as it takes some time to digest in their body and provide them with energy for a longer time.

Digiteri: Exactly. Don't be fooled by its small size, eggs can be very filling for children. And when they are full, with enough protein, choline and all the other nutrients, they have a better chance of performing well in school.
Namahoro: So what you are saying is that we should not only focus on foods that will fill the children's stomach, but also add eggs to their meals which will give them good nutrition.
Digiteri: Yes! This is why I was telling you that eggs are very important in the growth of children and the development of the mind. And if you want to learn more about how eggs can help your child, just ask Patrisya, she is a health mobiliser and can tell you a lot.

Yes, eggs are precious, but our children are even more precious… Invest in their diet to give them the best chance at a successful life.

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END!

Spot 3: (Opportunity Costs)

The campaign goals

CHARACTERS:

Kazungu: Shop attendant
Bwite: Parent who newly learned the importance of eggs for children
Mahoro: Parent who newly learned the importance of eggs for children
Fabiyani:*a man*: He is a Poultry Farmer, at his home they don't eat eggs because they sell all eggs and buy other necessities. Saying that eating eggs is for rich people.
Mutoni: *Woman*: Fabiyani's wife.

VENUE OF THE SKETCH:
At the shop

THE ACTUAL SPOT

(Mutoni and Fabiyani at kazungu's shop)

Muto: Kazu, Can you measure 4 kgs of beans for me, and add 5kgs of irish potatoes.
Fabiyani: Please don't take them all, measure for me 3kgs and see if I can reserve some money for the beer!
Bwite(Coming in the shop singing and find Fabiyani there)
Bwite: You are all buying as if you have visitors, you must have made some money Fabiya?

Fabiyani: *(laughs)* you're joking, it's only two bottles of beer for me to relax.
Bwite: In that case, can you add a few eggs for the children on what you are buying. I will buy some too!
Fabiyani: You say eggs! Hahaha but do really people have the money to waste! My family and I have not yet reached the stage of eating eggs. That's for rich people.
Mutoni: *(Laughing)* Bwite, it seems like you're the one who must have made some money recently. Can you not see how eggs are so expensive?
Bwite: Mutoni and Fabiyani, it seems you don't understand why eggs are important to your children's well being, did you know that they even help with a child's brain development? I also had this conversation with Mukandekwe. As you understand, a caring parent is always mindful of his or her child's health, because that is what determines how he or she will grow up.

(Mahoro entering the shop to buy eggs)

Mahoro: Hello everyone, Bwite I hope you've advised Fabiyani's family to feed their children eggs as the health worker told us?
Bwite: I am lucky you're here too, can you tell them what the headmaster and health worker told us?
Mahoro: Brother Fabiyani and sister Mutoni, This is the reality. Just by adding two or three eggs per week to their meal, your children get nutrients to grow smart and strong. Now whenever I go shopping, I always set aside money to make sure I can get eggs for my children depending on the money I have.
Mutoni: So, you mean the little money I get to not buy other necessities, and rush to buy eggs. How many days do you think they can eat them? And do you think tomorrow they will not need clothes? How about health insurance?
Bwite: Muto, I really understand you. I'm not saying you should not pay for your necessities, As parents, we can always try to think of what we can do to give the children the food that is best for them. For me now, I don't want to always be buying eggs in the market as it can be expensive. Mukandekwe and I have decided to save some money and buy chickens. It's a great idea for each home to raise at least one chicken. That way, the children can get eggs from our own chickens.
Mahoro: Yes, thinking of the benefits eggs can give my children, I decided to reduce a little bit of the refreshments I used to buy in the house. If it's something that is not necessary, I would rather save that money and use it to get eggs for my children.
Bwite: And Fabiya, I know you raise chickens, but you sell off all without leaving a few for your children saying that eggs are for rich people. Why not save those eggs for them?
Fabiyani: But isn't that what My wife was telling you? a person needs a lot of things at home. The money I get from those eggs is what we use to pay for some things at home
Bwite: I do not deny this, however, nothing should come before the life of your child. When chickens lay a lot of eggs you can sell, but don't deny your children a chance of getting essential food, which they need to grow up healthy. Fabiya, save some eggs for your children and reduce that beer you want to buy so you can use that money for the things at home.
Fabiyani: Hmmm, it's not like I can't do this but…
Mutoni: Bwite and Mahoro, I don't fully understand why you say eggs are so important but I must say that to me, my children's wellbeing is the most important. Fabiya, maybe we can go home and see where we can save some money?
Bwite: Yes, please do that. Fabiya, we can even find some other time so I can explain to you in detail why I am making so much effort to feed my children eggs.

Eggs are precious, but our children are even more precious… Invest in their diet to give them the best chance at a successful life. Tune on Radio Salus everyday to listen to this message.
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Spot 4: (Excess / Recommended Consumption of Eggs)

Duration: 180 seconds

CHARACTERS:

Mukashema: Mukandeke's mother, Nancy's grandmother
Kankindi: Mukashema's friend - has some misconceptions about the effects of eggs on children
Nancy: Mukandekwe & Bwite's daughter, Mukashema's granddaughter
Bwite: Parent who newly learned the importance of eggs for children
Mukandekwe: Bwite's wife, a parent who recently started feeding her children eggs.
Fabiyani:*a man*: He is a Poultry Farmer, at his home they don't eat eggs because they sell all eggs and buy other necessities. Saying that eating eggs is for rich people.

VENUE OF THE SKETCH:
At Mukashema's house.

SCENARIO:

Mukandekwe has sent Nancy to deliver beans to her mother. Mukashema dotes on her granddaughter and gives her a boiled egg to eat, before sending her back.
Kankindi witnesses this and expresses concern. Mukasheam corrects Kankindi's misconceptions and expresses that it is the responsibility of the whole family and community to ensure that children are raised well.

She advises Kankindi to share her newfound knowledge with her own family.

THE ACTUAL SPOT 4

At Bwite and Mukandekwe's home

Mukandekwe: *(Shouting)* Nancy! Come here Quickly !
Nancy: *(laughing and panting)* Ma?
Mukandekwe: Didn't I tell you to take this basket of beans to your grandmother? How come you're still here? Quickly go and deliver it! Your friends will still be here when you come back.
Nancy: I'm going now! I'm going now!
Mukandekwe: Don't fall!
(SFX: Nancy running off with the basket of beans)

Mukashema and Kankindi at Mukashema's Home

Nancy: *(Knocking)* Nyogoku! I have come with a basket!

Mukashema: Is it you Nancy? Please come inside my child...I was conversing with my friend Kankindi.

Nancy: Good afternoon Nyogoku. Mom sent me to you with this basket, I have brought it here...

Mukashema: Good child! Good child! Put it down in the kitchen. Have you eaten already?

Nancy: Yes, I came after having lunch at home...

Mukashema: But I know you will still like to eat an egg right? Take one from the pot in the kitchen.

Nancy: Yes I love eggs, when I eat them, I feel even stronger! Thank you Nyoku! Can I take one for my brother?

Mukashema: Yes, yes! Take one for him too. And quickly go back home. It's getting late
Nancy: Yes, Nyogoku …

SFX:(Leaves running)

Kankindi: Nancy can run very fast...

Mukashema: (Laughs) Yes. That child is so full of energy all the time!

Kankindi: It's good. It shows she is healthy. But Mukashe, did you give her eggs again? You already gave her yesterday when she came. Listen, I know you say eggs are good, but you should know that you cannot give children too many eggs!

Mukashema: Of course, too much of anything will not be good. Because you said this last time, I went with Mukandekwe to ask the health worker and in fact, she said feeding children one egg everyday is not harmful but very beneficial for them.

Kankindi: Really?

Mukashema: Yes! You know eggs even help prevent many diseases, so rather than causing problems, eggs help children to grow stronger, especially children under the age of 5. Didn't you see Nancy? Since we started giving her eggs regularly I've seen that she remembers things more easily and Mukandekwe even says that her grades at school have improved.

Kankindi: That's impressive...

Mukashema: You too can go and make sure your daughter is feeding her children a balanced diet that includes eggs in addition to healthy foods.

Kankindi: But you know our situation, they have many children. To give all of them one egg everyday... It will be hard...

Mukashema: Kanki, I'm not saying that you're obliged to give them one egg everyday. You can also feed children 2 to 3 eggs a week, this means one egg for two or three days. This will help them to grow healthy.

Kankindi: Let me discuss this with my daughter and see what she says...

Mukashema: That's for the best. It can even help them if they keep a chicken at home, so they don't have to worry about buying eggs everyday. That's what Mukandekwe and Bwite are doing.

Kankindi: That will be way cheaper for them!

Mukashema: Kanki, the truth is that eggs cost money, I know. But these children are our future. They are more precious than anything. So it is all our responsibility even as the community to make sure they grow well.

Kankindi: You are very right.

Eggs are precious, but our children are even more precious… Invest in their diet to give them the best chance at a successful life.

Tune on Radio Salus everyday to listen to this message, *brought to you by Tubura, your trusted partner*

SPOT 5:

The campaign goals

This spot will provide parents/primary caretakers with practical tips and information on how to incorporate eggs into their children's diets. It will also highlight the recommended quantities, as well as different ways to cook eggs and make it taste good for children. The episode will also emphasize how to add this to the family's daily/weekly routine and make it a more regular habit.

CHARACTERS:

1. **Francoise:** Nancy and Kagabo's Teacher
2. **Nancy:** Mukandekwe & Bwite's daughter
3. **Kagabo:** Mukandekwe & Bwite's Son
4. **Bwite:** Kagabo and Nancy's Father, Mukandekwe's Husband
5. **Mukandekwe:** Bwite's wife, Nancy's mother.
6. **Patricia:** The community health worker

VENUE OF THE SKETCH:
At Bwite's home

SCENARIO:

- There is a cooking session at Patricia's home, who is a health worker. She is teaching Bwite's Family, Fabiani anad Knakindi how to prepare different egg dishes.
- Patricia will remind them the right quantity to feed the children
- Patricia passes by the Bwite's home to remind them about the session and they're all hurrying up to go and attend the meeting.
- Bwite's Family, Fabiyani and Kankindi will have a chance to ask all questions they have regarding the egg dishes to be cooked, how much quantity to prepare and how to mix it with other food to make a balanced diet.

THE ACTUAL SPOT 5

At Bwite and Mukandekwe's home

SFX: Kagabo and Nancy coming back from school in the afternoon

Nancy: (Excited) Maammmmmm mamama, look here! We have Omelette with Vegetables. In today's cooking lesson, Teacher Francoise made them for us...Maaa Have this one and taste**.**

Mukandekwe: Uhmmmmmm they're delicious

Kagabo: (Eating) Uhmmnnnnn Mamaaa… the omelette is very delicious...Maa tomorrow can you prepare it for us too?

Bwite: Boiled eggs are enough! Don't you know that frying the egg can make it less nutritious?

Nancy: But Paaaa...

SFX: Patricia Knocking

Patricia: Good afternoon Family Bwite! I can see that Nancy and Kagabo are enjoying their food.

Nancy: Aunty Patri we are eating omelette with veggies. Do you want to try some?

Patricia: (Laughs) No, but thank you my child. Mukande, it's really good that you are giving them different egg dishes.

Mukandekwe: Patrici, they brought this from their school. In fact, we were just saying that frying the eggs is not too healthy for the children

Patricia: Noo, not at all. Then it's a good thing that I am here. I was passing by and said I should pick you up for nutrition training… Today, I will teach about different ways to cook eggs for children… Bwite will you come too?

Bwite: I will! Mukande let's go… We can drop the children at their grandmother's house on the way

SFX: On their way going, excited and talking

Patricia: (At her home) Gramaa-Kankindi and Fabiani.. I am glad that you're here too. Let's first sanitize our hands and keep the distance between us. Today we're going to learn about egg dishes we can cook for our children. Let me know if you can see from where you are sitting

SFX: ALL OF THEM… We can see

Patricia: Good! Normally, you should feed your child at least 2-3 eggs per week. The easiest way to do this is to just boil the eggs and add it to your child's meal. I know this is what a lot of you do.

Fabiani: Yes, that's what we do.

Patricia: But you know, you can also cook the egg in different ways. For example, you can fry an egg for your child and add vegetables…

Bwite: Patri, doesn't frying the egg make it unhealthy?

Patricia: Not at all! Frying or boiling the eggs, the children get the same nutrients from it, just don't use too much oil when frying.

Bwite: Really?

Patricia: It's true. In fact, you can even add other vegetables like onions and tomatoes to the eggs when frying. Like what your children were eating today, Mukande.

Mukandekwe: Yes, they really liked it.

Patricia: See? It is good to try different cooking methods to keep your child interested in eating. Another way you can try is just adding the eggs into other meals that you are already cooking. For example vegetables, rice, potatoes…

Kankindi: What about porridge?

Patricia: Thank you Kanki, you can also add it to porridge. In the morning, I just add eggs into my children's porridge when cooking it and they love the taste! And, it keeps them full for longer during the day.

Fabiani: Patricia, can you show us how to do this?

Patricia: Yes, look I have prepared the ingredients including Onions, tomatoes and Poivron. Let's first start with the fried eggs. Kanki, please take these eggs and break them, Mukande, you too can put these eggs on the pan after the ingredients.

SFX: THEM COOKING…

Patricia: Now our Omelette is ready, try this...

Mukandekwe: Uhmmmnnnn!! it tastes so good, Patrici.

Everyone else agreeing: Yes! It's good!

Patricia: So your children will also think it is good! Next time, we can talk about what else to add to your child's meal, so they are eating a balanced diet.

SFX: ALL SAYING THANK YOU , THANK YOU, THANK YOU SO MUCH
Let's go home and start practicing what we have learnt

(Slow Music on their way going home)

Eggs are precious, but our children are even more precious… To learn more, ask your closest Tubura Field officer about the Nutrition training and tune in on Saturday to listen to our Expert show. ***This message is*** *brought to you by Tubura, your trusted partner.*

Appendix C: Field Officer Training

Objective: To teach farmers about feeding children eggs and its benefits, and discuss strategies to ensure availability of eggs in the household

Farmers will be able to…

- **Explain** the importance of feeding children eggs
- **List** the best practices for feeding children eggs
- **List** ways to ensure availability of eggs in the household.
- **Discuss** the challenges of feeding children eggs and solutions to overcoming these challenges.

Materials:

- Training document
- Poster with images
- Audio recording in the tablet

Time: 1 hour 5 minutes (65 min)

Introduction (5 minutes)

SAY: Everyone close your eyes. Picture a very healthy child with good brain development; What is he/she doing? What do you think he/she can accomplish in life with a healthy start in life? *Give them 1-2 minutes to think*

ASK: Can I have a few people to volunteer to share their thoughts with the group? *Encourage them to share their ideas and thank them for participating*

SAY: Today we would like to talk about something we can do to give our children a healthy start in life: feeding them eggs.

Why It Is Important To Feed Children Eggs (10 minutes)

ASK: Why is it important to feed children eggs? *Let them give answers and highlight the correct ones*

SAY: *Eggs are full of **energy, protein** and other nutrients a child needs for a strong body, good health and a **healthy brain development** therefore it improves a child's ability to learn.*

- *Just one egg contains more important **vitamins** than a potato*

DO: Show 1 to participants then ask, what do you see and understand from this image? *Let them give all possible answers. Here are some answers; read out only those that have not been mentioned*

- *Mother peeling an egg while father is standing next to her looking proudly at their healthy child playing*
- *Two ladies admiring the healthy child playing*

SAY: Adding an egg to your child's diet **2-3 times** a week is a smart investment in your child as it helps them grow a healthy and strong body and smart minds.

How to Feed Children Eggs (15 minutes)

DO: Point to image 2 then **Ask**: What do you see in this image? *Let them highlight the differences between the children and mothers*

- *One child is calmly playing while his mother is talking to the other mother whose child is carried and looking sickly*
- *One mother is happy while the other is worried*

DO: Role play

You are going to **act** as the two mothers discussing their children, one has a healthy child (Agnes) and another with a child who does not look very healthy (Jane). You will **read out** the statements said by Jane and Agnes in the word bubble. Jane is worried about how her two year old child is not is not feeding well and has no energy.

Jane says, *"I worry my child is not getting enough energy, he refuses the food I make, he is cranky, maybe he is not getting full"*

Agnes replies, "*Try adding an egg with his food next time, it's not always easy, but surely cheaper than meat, fish or porridge like cerelac. I used to have the same problem, but every time I add an egg to my child's porridge, sweet potato or even as a snack, he finishes his meal and he looks so happy, it makes me smile. It keeps him full for hours, he plays or sleeps and it give me time to do things in the house*"

ASK : What did Agnes do to solve the problem of her child not getting full and having no energy ? *Let them give the answers based on the role play*

- She added eggs to the child's food

ASK: How did Agnes benefit from adding eggs to the child's food? *Let them give the answers*

- The child started finishing his meals
- Child became happy and this made Agnes happy too
- The child became full for many hours and Agnes had time to do other things in the house

SAY: A smart farmer, even if they may not have much, knows how to be smart with their resources and make the best choices for their children by feeding them eggs frequently
ASK: When is it okay to introduce eggs in a child's diet? *Let them give the answers*
SAY: From when a child is **6 months of age,** it's okay to introduce eggs in their diet since at this age breast milk alone is not enough for him/her. This will help the child to have **good brain development** and **growth**.
ASK: How many times in a week is it okay/best for you to feed children eggs? *Let them give the answers*
SAY: It would be a big benefit to them to feed children **2- 3 eggs a week**. Feeding even an egg a day is also beneficial (it is not bad for their health), but we recognize that this can be unrealistic for many families. The protein in the eggs is good for the child, it helps them avoid having kwashiorkor.
ASK: What part of the egg can children eat? *Let them give answers*

SAY: The baby should eat both the egg yolk and egg white because they both contain protein which is important for the growth of children.

Ensuring Availability of Eggs to Feed Children (5 minutes)

SAY: Raising chickens is difficult, we know! But we want to talk now about some strategies to ensure that you can have enough eggs to feed some to your young children

ASK: How can you ensure that you have enough eggs to feed children? (*Take some suggestions from farmers and highlight the good ones then **read** the two below)*

- *Practise good chicken rearing practices, like building a pen to put chickens in at night so they lay eggs there.*
- *You can collect them and store in a cool, dry place to avoid losing eggs due to spoilage*
- *If you have laying hens, ensure you reserve some eggs to feed your children*

DO: Point to image 3 then ask, what is happening in this image? *Let them give all possible answers.*

- *Mother coming from the market with eggs in a basket*
- *Mother holding her child who is coming from school*

SAY: This is a smart mother who even if she may not have eggs at home, has gone to buy from the market to feed her child to ensure he has a ***good brain development*** to learn well in school.

ASK: What do we learn from this smart mother? *Let them give answers*

- *If don't have eggs, remember to buy eggs them from the market*

SAY: You can also **barter/trade** with a neighbor or friend who has eggs in exchange for other goods you can offer them

How to prepare eggs (5 minutes)

ASK: How do you normally prepare/cook eggs? What different ways can you prepare eggs to feed young children? *Let them give their ideas on cooking eggs*

- *Boiling eggs*
- *Frying in a little oil (with or without onions and tomatoes)*
- *Adding them to other foods*

SAY: It is good to vary cooking methods of eggs to keep your child always interested.

DO: Point to 4 and ask, what do you see from this image? *Let them give all possible answers*

- *Children are playing calmly*
- *Mother is adding eggs into porridge*

ASK: Are there any other foods that you can add eggs to? *Encourage them to give examples*

- *Vegetables, rice, porridge, potatoes, among others.*

SAY: One egg mixed into a child's meal in the morning will keep him full for a good portion of the day and give him the energy he needs

Activity 1 (15 minutes)

DO: Split participants into groups of four or five.
Each group should discuss two questions:

1. **Identify challenges: Is there anything that makes it difficult to feed your child eggs?**
2. **Identify solutions: How can you solve that problem?**

After 10 minutes,

- Form one large group and ask one person from each group to stand and present her/his group's challenges and how they solved them.
- Encourage participants to share experiences to solve problems.

Notes for FOs:

- *Read through the challenges and solutions below* ***before the training****.*
- *For each challenge; Take some suggestions from farmers and highlight the good ones*

Possible challenges and solutions

Example 1

Challenge: *My child does not like eggs*

Solution: *Prepare eggs using different cooking methods to find the one he/she prefers*

Example 2

Challenge: *I don't have eggs to feed children/Eggs are expensive*

Solution:

- *Practise good chicken rearing practices so that you can have your own eggs to feed children*
    - Giving them clean water everyday because chickens need water for survival, growth, activity and egg production
    - Provide extra food for laying hens so they don't waste energy scavenging, and can lay more eggs
    - Feed chicks with foods that have protein, like **cooked** beans, soy, peas, cowpeas, fish (these could be **leftovers from meals**), insects, maggots, or termites, so they can grow faster and stronger
- *Sometimes you can barter them with your neighbour/friend if you have no money to buy*

Example 3

Challenge: *Consuming too many eggs is not good for health; Eggs contain protein which is not good*

Solution: *Feeding even an egg a day is **not** bad for children's health. There is a lot of research done that prove that the **protein in the eggs is good** for the child, it helps to build and repair their body.*

Activity 2 (5 minutes)

ASK: Have you heard about the Egg drama on radio Salus this week?

DO: Play for the participants the audio file to the end without interruptions

ASK*:* What do you think about this story? (*Try to understand if they like or dislike it*)

ASK: What do you think this story tells us? *Discuss with participants to get their point of view. Here are some key messages to pass across:*

- Eggs also make the child to be full
- Eggs are important in child brain development so they can be able to learn well
- Eggs are a cheap way to get protein that is good for growth and development of children

SAY: Don't forget to listen to more episodes of the Egg drama on radio Salus!

Conclude/Review (5 minutes)

ASK: What have we learned today? *Let them give all possible answers and thank them for remembering*
SAY: Today we learned that:

- Adding an egg to your child's diet **2-3 times** a week is a smart investment in your child as it helps them get full, grow a healthy and strong body and smart minds.
- A smart farmer; even if they may not have much, knows how to be smart with their resources and make the best choices for their children by saving eggs and feeding them to their children

SAY: Now each of you spend a moment to think about one action you can take to begin feeding children eggs as per the recommended frequency. *Give them 1-2 min.*

ASK: Can I have a few people to volunteer to share their commitments with the group?
SAY: Thank you for your commitments! Let's give ourselves a big clap!

Appendix D: Text Message Reminders

DATE	CONTENT	TEXT MESSAGE *English*	Rationale/Barrier being addressed on radio
JUNE			
Fri 4th	Introduction message	Hello! Welcome to Tubura's new 6-month program on feeding children eggs for good growth, health and smart minds. There will be training by FOs	Introduce trial participants to know what to expect in this trial
Mon 7th	Introduction message 2	In this Egg program, tune in to listen to drama episodes on Radio Salus and health experts to answer questions about feeding children eggs. Don't miss out!	Nutritive value of eggs
Mon 21st	BC Nudge	Did you know that eggs are full of nutrients a child needs for strength, health and brain development? Raise chicken and feed your child 2-3 eggs a week!	
Mon 29th	Serial drama release	Episode 1 of the Egg drama is now out! It will be playing on Radio Salus this month. Don't miss out! Tune in to listen	Egg alternatives
JULY			
Mon 19th	Listenership drive	Don't miss out on Tubura's Egg drama episodes on Radio Salus and health experts to answer questions about feeding children eggs!	
Mon 26th	Listenership drive	Share what you learn with your friends and neighbors and encourage them to tune in to radio Salus to hear about Tubura's egg drama episodes	
AUGUST			
Mon 2nd	Call to action	Share what you learn with your friends and neighbours and encourage them to feed children 2-3 eggs a week for growth and good brain development	
Mon 9th	Serial drama release	Episode 2 of egg drama is now out! It will be playing on Radio Salus this month. Don't miss out! Tune in to listen	
Mon 16th	BC Nudge	Did you know that eggs are just as nutritious as meat and fish! Feed your child an egg today to get these important nutrients!	
Mon 23rd	Call to action	Share what you learn with your friends and neighbours and encourage them to save eggs to feed children for a healthier family	
Mon 30th	Serial drama release	Episode 3 of the Egg drama will be playing on Radio Salus. Don't miss out! Tune in to listen with your friends and family!	Opportunity cost
SEPTEMBER			
Fri 10th	BC Nudge	You play and important role in your community. Feed your children eggs and others will see how healthy they become and follow your good example!	

DATE	CONTENT	TEXT MESSAGE *English*	Rationale/Barrier being addressed on radio
Thur 16th	Call to action	Share what you learn with your friends and neighbours and encourage them to follow your good example of feeding children eggs	
Wed 22nd	Serial drama release	Episode 4 of the Egg drama will be playing on Radio Salus. Don't miss out! Tune in to listen with your friends and family!	Excess egg consumption
Mon 27th	BC Nudge	Did you know that feeding your child even 1 egg a day is beneficial to their health, growth and development?	
Thr 30th	Exper-show nudge	Expert show on Egg alternatives will be playing on Radio Salus this saturday. Don't miss out! Tune in to listen to at 8:30 Am with your friends and family!	
OCTOBER			
Mon 4th	Call to action	Share what you learn with your friends and neighbours and encourage them to feed their children 2-3 eggs a week for them to have good health	
Mon 18th	Serial drama release	Episode 5 of the Egg drama will be playing on Radio Salus. Don't miss out! Tune in to listen with your friends and family!	How to feed children eggs
Mon 25th	BC Nudge	Have you tried this new recipe of frying onions and tomatoes then adding eggs and a little salt this week? Eat this with rice, potatoes or other meals	
NOVEMBER			
Mon 1st	Call to action	Share what you learn with your friends and neighbours and encourage them to try out new ways of preparing eggs for young children by adding it to other meals	
Mon 8th	Serial drama release	Episode 6 of the Egg drama will be playing on Radio Salus. Don't miss out! Tune in to listen with your friends and family!	Soicial perception (eggs are for the rich)
Mon 15th	BC Nudge	Feeding children eggs is about being smart; today, can you be counted among the smart farmers who save some eggs to feed to their child 2-3 eggs a week?	

Appendix E: OLS Regression Results for Varying Level of SBCC Exposure

Difference in reported weekly egg consumption for children under 5 between baseline and endline for groups with varying levels of SBCC exposure

	Listened to radio AND hung poster AND attended training		**Listened to radio OR hung OR attended training**		**Listened to radio**		**Had poster hanging**		**Attended training**	
	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value	Coeff	p-value
Subgroup (1=yes, 0=no)	0.085	0.694	0.055	0.733	0.083	0.552	0.063	0.664	-0.012	0.939
Female caregiver	-0.125	0.365	-0.129	0.354	-0.123	0.367	-0.129	0.357	-0.131	0.348
Number of cows	-0.029	0.560	-0.030	0.546	-0.027	0.581	-0.029	0.552	-0.028	0.572
Married	-0.312	0.280	-0.312	0.281	-0.321	0.269	-0.311	0.283	-0.311	0.283
Some secondary Education	-0.162	0.377	-0.158	0.402	-0.162	0.378	-0.159	0.396	-0.151	0.423
Age of respondent	-0.003	0.726	-0.003	0.735	-0.002	0.759	-0.003	0.719	-0.003	0.750
Ubudehe	0.107	0.309	0.105	0.319	0.107	0.305	0.105	0.319	0.106	0.318
Household size	0.001	0.990	0.001	0.983	0.000	0.993	0.001	0.980	0.000	0.998
Constant	0.443	0.372	0.412	0.402	0.407	0.421	0.432	0.381	0.460	0.347
Observations	684		684		684		684		684	
R-squared	0.005		0.005		0.005		0.005		0.005	